America's First Aeronautical Magazine

AVIATION

JULY 1945
50 CENTS PER COPY

IN THIS ISSUE

WILL IT BE PLANES VS. CIVILIZATION?

T. P. Wright analyzes aircraft's place in the world, and tells what must be done to make it an instrument of peace.

★

UTILITY—KEYSTONE PLANE MARKETS

method of measuring plane usefulness and of determining the size markets which can be anticipated.

★

DESIGN ANALYSIS OF CONSOLIDATED B-24

Complete design and structural details of famed heavy bomber prepared by the "Lib's" own Chief Design Engineer.

★

ENGINEERING THE SHOOTING STAR

How Lockheed delivered a radical new fighter, the P-80, in unbelievable time of 143 days—told by the man who directed the job.

★

FOUR NEW JAP WARPLANES

First published specifications and performance on newest Nip combat craft, together with Aviation staff artist sketches.

McGRAW-HILL PUBLISHING COMPANY, INC.

AVIATION

CONTENTS FOR JULY, 1945

Volume 44 • Number 7

The Aviation News

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BRIEFING

Last month we shot the works talking about Ralph Upson's series and, normally, wouldn't be leading off about it again. But as we present the second article of the series we'd like to double it all in spades, for he has really done a job. This month (beginning on page 145) he comes through with what amounts to preliminary design on no less than five possible personal plane types, comparing the advantages and disadvantages of each. The engineering data going with this installment will serve as real A-1 reference material.

Again we're proud to present one of AVIATION'S inimitable Design Analyses,—we say proud because we've been told they're jobs that haven't been touched in the aeronautical publishing field. This time it's Consolidated Vultee's famed B-24 Liberator, written in complete detail by J. H. Famme, Chief Design Engineer at Convair's San Diego Division where the Lib was born. Turn to page 121.

A lot has been said about sonic speed, but there is still much more to be done about it. With the opening of the Southern California Cooperative Wind Tunnel, though, that picture should be changing soon, for this new tunnel is designed for research at better than 700 mph. Just what the tunnel is and how it works is told by its Director, Dr. Clark B. Millikan, in the complete article beginning on page 155.

Plenty of new airplanes this month—six military types and two brand new commercial jobs. Military group includes: The Avro Lincoln (page 164), first British bomber in the Superfortress weight class. Included is our staff artist's sketch of this latest mammoth warcraft to go into production. . . . First photos and data on Grumman's new F7F Tigercat (page 170), a twin-engine fighter which the Japs are *not* going to like. . . . And first published sketches and specifications on four new Nip warplanes—George and Frank 1, fighters; Judy 33, carrier-based dive bomber, and Peggy 1, an army recon-bomber (pages 171 and 172). Commercial models featured are: The Aero Commander (page 163), a twin-engine, five-six-place craft designed on the West Coast. And de Havilland's Dove (page 169), proposed eight to eleven passenger craft greatly resembling Britain's justly famed Mosquito bomber.

ROY HEALY, vice-president of the American Rocket Society, is shown here with rocket-firing North American P-51 somewhere in Burma where he was assigned as technical observer when this new type weapon first went into action in that theater. In the first of a two-part series, beginning on page 152 Mr. Healy forecasts some mighty startling possibilities for rockets—in peacetime as well as wartime uses.

We have two feature stories in the Marketing section this month. Our initial article injects some brand new thoughts into the postwar personal plane market potentials. Here, for the first time, utility has been defined and rated so that, by using the method described, each manufacturer or distributor can reach his own estimates of what market he thinks he can corner for himself. Turn to page 113.

The second feature clarifies the misunderstanding which has grown up around the disposal of surplus aircraft and, more important, shows how money has been made and can still be made in this field. See page 118.

Down the Years in AVIATION'S Log

25 Yr. Ago (1920)—Air Mail service reports 85 percent trips completed in past year. War Dept. designates eight airfields for reserve officers' flight practice. . . . Goodyear's Pony Blimp passes tests. Packard builds 600-hp V-12 engine weighing less than 2 lb per hp. . . . Farman Goliath, piloted by Bossoutrot and Bernard, breaks endurance record with 24 hr. 19 min. flight.

15 Yr. Ago (1930) — Radio first used in solo flight instruction. Kingsford-Smith flies Fokker F-7 in first westward trans-Atlantic flight, his speed averaging 70 mph. . . . Roger Williams flies non-stop, New York City to Bermuda and return, in 17 hr. in Bellanca "Columbia". . . . Amelia Earhart, flying Lockheed Vega, breaks women's speed record at 174.9 mph. . . . Detroit Aircraft's Gull gets first glider certificate. Stanley Huffman of Cincinnati flies Aeronca for 25 hr. 42 min. . . . PAA starts 1,800-mi. mail service along east coast of South America. Union Oil of Calif. subsidizes glider instruction for employes.

10 Yr. Ago (1935)—Alaska Transport formed at Juneau. Dept. of Commerce plans to spend $2,000,000 on airfields for Alaska. Bowles airport at Springfield, Mass. is taken over by horse racing syndicate. . . . Washington Aircraft Corp. of Seattle issues fuel-credit cards to cross-country pilots. . . . PAA Clipper makes first flight to Midway. . . . Kellett Autogiro lands mail on Philadelphia Post Office roof.

Sign of the Times

So you're going to operate an air taxi! Well, it may not be long, now . . . you'll put the finishing touches on the sign over the office door, insert your first ad in the daily paper, and take up a strategic position by the telephone to greet your first customer.

But in planning and working for this big moment, you will have faced three paramount requirements of successful operation: safety in flight operation and navigation, economy of operation, and ability to render around-the-clock, around-the-calendar service to the public.

You will find the answer to these requirements in high quality instrumentation — *complete* instrumentation. And it is in this phase of commercial aircraft operation that Kollsman can serve you. Kollsman Aircraft Instruments have played a vital part in the success of the nation's airlines since their earliest days.

Whatever your operation is to be, Kollsman accuracy and dependability can be one of your greatest assets, too!

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Write today for our interesting and informative booklet "Facts About Kollsman Aircraft Instruments." Kollsman Instrument Division, Square D Company, 80-20 45th Ave., Elmhurst, New York.

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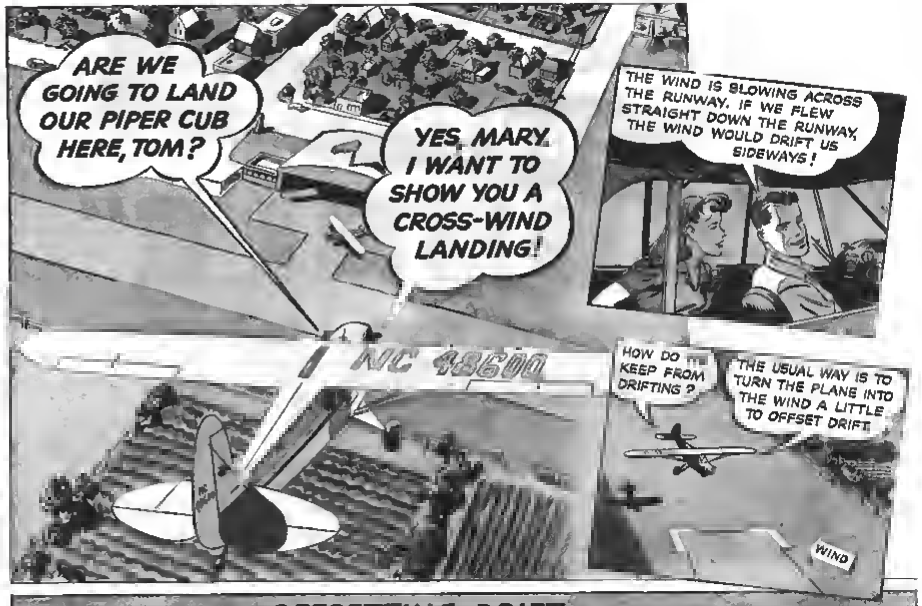

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Points the Way to Wings for ALL Americans

PIPER AIRCRAFT CORPORATION
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NOW YOU CAN HAVE

CONTROLLED

"BUBBLE" CANOPY

—built by Goodyear Aircraft

Controlled for better visibility
Controlled for better fairing
Controlled for better airflow

GOODYEAR can now offer this superior type of control-blown "bubble" canopy because it originated new standards of manufacturing this "pilot's greenhouse." Extensive experimental and developmental work with Lucite and Plexiglas corrected the processing flaws that led to product flaws. Heretofore, it had been thought that the price of perfect vision in free-blown canopies was a handful of aerodynamic undesirables: bad bulges and poor fairing to surrounding structures.

By developing unique methods of shaping the canopy under control-blown processing, Goodyear Aircraft achieved satisfactory control of the shape while retaining excellent optical properties.

Perfect contour — reduced bulges — excellent fairing

The Goodyear Controlled Canopy eliminates undesirable bulges—thus reducing drag to the fullest extent possible with this type of pilot housing.

And when it comes to fabricating support mechanisms, windshield details, jettison fittings—that is playing on the home grounds for Goodyear, because of aviation experience that traces back to 1909!

Arrows indicate differences between old and new types of control-blown canopy. Note elimination of bulge and the improved fairing made possible by Goodyear's control-blown "bubble" canopy, seen at bottom.

Goodyear Aircraft tackled the task of producing this ideal canopy, not as a fabricator of plastics but as an aircraft manufacturer. Another vital piece of evidence that a long accumulation of aeronautical information is of great value to the design groups of plane builders.

Already a subcontractor for many other vital components of leading military aircraft, Goodyear now stands ready to make its engineering talent and production facilities available for original design conception and the manufacture of complete canopies to specifications.

* * *

Goodyear is building components for 16 different Army-Navy types of aircraft, including complete Corsair fighters and airships.

GOODYEAR AIRCRAFT CORPORATION
Akron, Ohio • Litchfield Park, Arizona

GOODYEAR AIRCRAFT

AVIATION, July, 1945

The New GOODYEAR

ALL PURPOSE AIRPLANE TIRE

Sets New Standards

Greater Ground Contact, Greater Impact Absorption, Longer Wear, Greater Protection Against Landing Hazards, Greater All-Round Usefulness

American fighter pilots are scoring heavily with powerful, hard-hitting aircraft. Note the rocket equipment under the wings.

THE last few seconds before you're airborne, and the first few seconds at the end of a flight — those are just about the most critical periods of any mission, jaunt or journey by air. So say experienced military, private and airline pilots.

That's one of the top reasons the new Goodyear All Purpose Tread Airplane Tire is being so warmly welcomed — it has built-in, paid-up security to meet the most extreme conditions.

It is a better all-round tire, giving added service and safety under varied operating conditions, because of these three standout advantages:

1. Increased flotation for high pressure tires, greater ground contact area.

2. Longer wear because it has additional tread stock, and accomplishes full cross-sectional contact with the ground without depending on distortion of the tread

3. Increased protection against rim cuts or other failures from rough landings, because sidewalls are sturdier with the stiffening of all purpose tread shoulders. This results in increased impact energy absorption.

This All Purpose Tread Tire meets important current needs for greater flotation in high-pressure tires. The Goodyear All Purpose Tire is made in a wide range of sizes.

TIRE, TUBE, WHEEL AND BRAKE—ALL GOODYEAR

This all-Goodyear landing gear is typical of the equipment now standard on many planes, from fast fighters to heavy bombers and transports. The all-Goodyear installation is assurance of matched perfection, unmatched performance.

Manufacturers, Airline Operators, Distributors, Dealers, and Private Flyers depend on GOODYEAR for—

TIRES • TUBES • WHEELS • BRAKES • AIRCRAFT HOSE • HYDRAULIC HOSE • HYDRAULIC PACKING • GASKETS • GRIPTRED • LIFE RAFTS • DUCTS • CHEMIGUM SHEETS • GLIDER RUBBER PARTS • FUEL AND OIL CELLS • RUBBER IZED FABRIC • ENGINE MOUNTS • AIRFOAM CUSHIONING • PLIOFILM • PLIOFORM • PLIOFOAM • HYDRAULIC PRESS PADS • MOLDED RUBBER PRODUCTS • ICEGUARD PROPELLER BOOTS

GOODYEAR RESEARCH LABORATORY — RUBBER SCIENCE HEADQUARTERS

GOODYEAR

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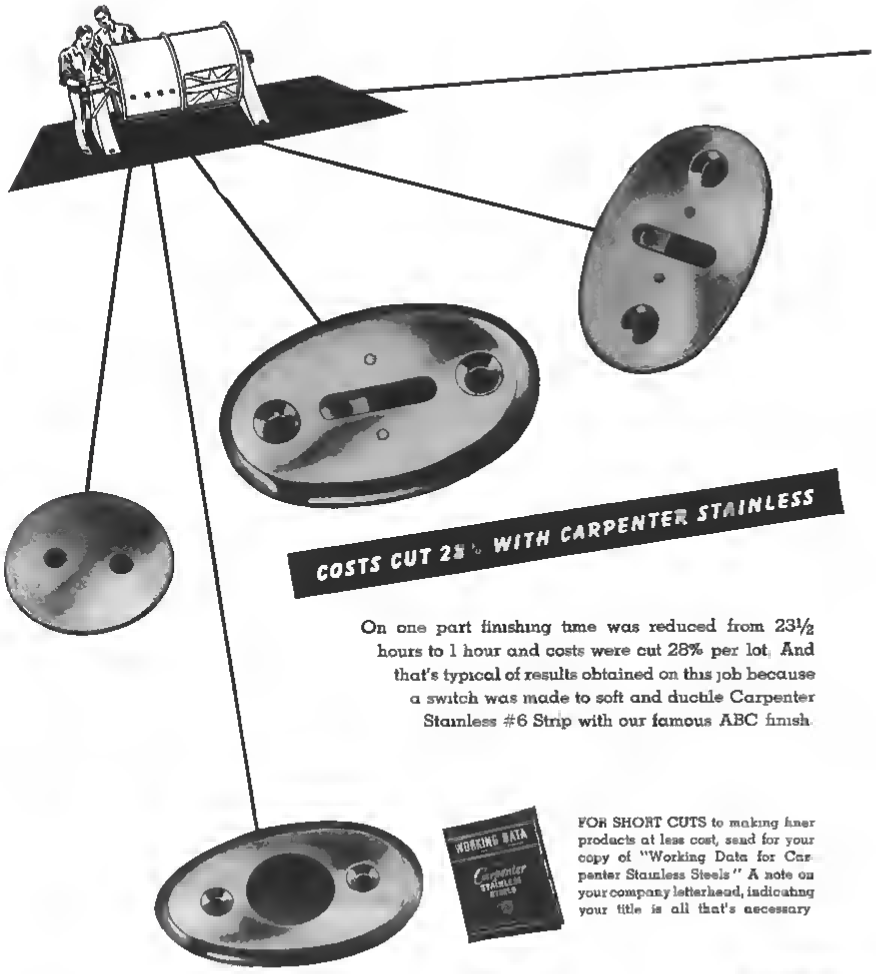
AVIATION PRODUCTS



COSTS CUT 28% WITH CARPENTER STAINLESS

On one part finishing time was reduced from 23½ hours to 1 hour and costs were cut 28% per lot. And that's typical of results obtained on this job because a switch was made to soft and ductile Carpenter Stainless #6 Strip with our famous ABC finish.

FOR SHORT CUTS to making finer products at less cost, send for your copy of "Working Data for Carpenter Stainless Steels." A note on your company letterhead, indicating your title is all that's necessary.

THE CARPENTER STEEL COMPANY, 128 W. BERN ST., READING, PA.

more than corrosion resistance

YOU GET CORROSION RESISTANCE *Plus* LOWER COSTS ON FINISHED PARTS

...with Carpenter Stainless

By starting with a stainless strip which has a bright, smooth surface, free from marks or scratches, you can eliminate many final polishing operations and substantially cut finishing costs. Read how one manufacturer saved up to 28% on one job, by switching from a nickel-plated non-ferrous metal to Carpenter Stainless Strip.

The plates on this truss are made from Carpenter Stainless #6 (Type 430) Strip supplied with our standard ABC finish. All that was necessary to secure a bright and gleaming surface was to blank and tumble these parts. Previously made from nickel plated non-ferrous metal they had to be blanked, polished, plated, final polished and buffed. Now instead of finishing each piece separately, job lots can be tumbled at one time, thus affording substantial savings in time and expense.

By using Carpenter Stainless Strip with a bright finish, you can reduce your finishing operations and cut production costs. In your planning of new or redesigned products investigate Carpenter Stainless Steels. Your nearby Carpenter representative can help you select the stainless and finish that will do the job best. Call him in today.

GIVE YOUR PRODUCTS THESE ADVANTAGES WITH CARPENTER STAINLESS

- Strength and Rigidity
- Heat Resistance
- Weight Saving
- Freedom from Rust
- No Plating to Peel
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- Longer Product Life
- Sales Appeal

Carpenter STAINLESS STEELS

BRANCHES AT
Chicago, Cincinnati, Cleveland, Detroit, Hartford, Indianapolis, New York, Philadelphia, St. Louis

Curtains for a Carrier: Martin Mariners cripple a Shokaku-class Jap flattop off Leyte

Wherever Navy airmen strike

IT'S TAPS FOR THE JAPS!

NO wonder Navy airmen are bad news to the Nips! With the world's best planes, most complete training, and highest morale, our naval fliers are more than a match for the Mikado's myopic monkeys!

Nipponese Nemesis

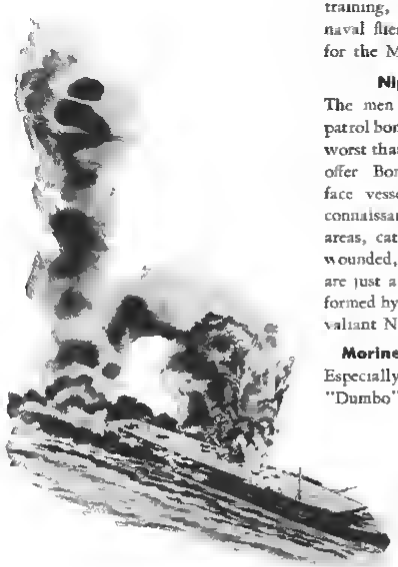
The men who fly Martin Mariner patrol bombers, for example, take the worst that the elements or enemy can offer. Bombing enemy subs or surface vessels, flying long-range reconnaissance missions over Jap-held areas, cargo-carrying or evacuating wounded, effecting rescues . . . these are just a few of the vital jobs performed by Martin Mariners and their valiant Navy crews.

Mariners Mean High Morale

Especially important are the "Dumbo" missions flown by the big 24-ton Mariners. Joining carrier-based planes in the thick of the fight, Mariners land, despite stormy seas or enemy fire, to rescue airmen downed in combat. Thus skilled Navy pilots and gunners live to fight another day . . . and morale among carrier-based airmen is kept high. Another reason why the Mariner is a headache for Hirohito!

Tomorrow, Too

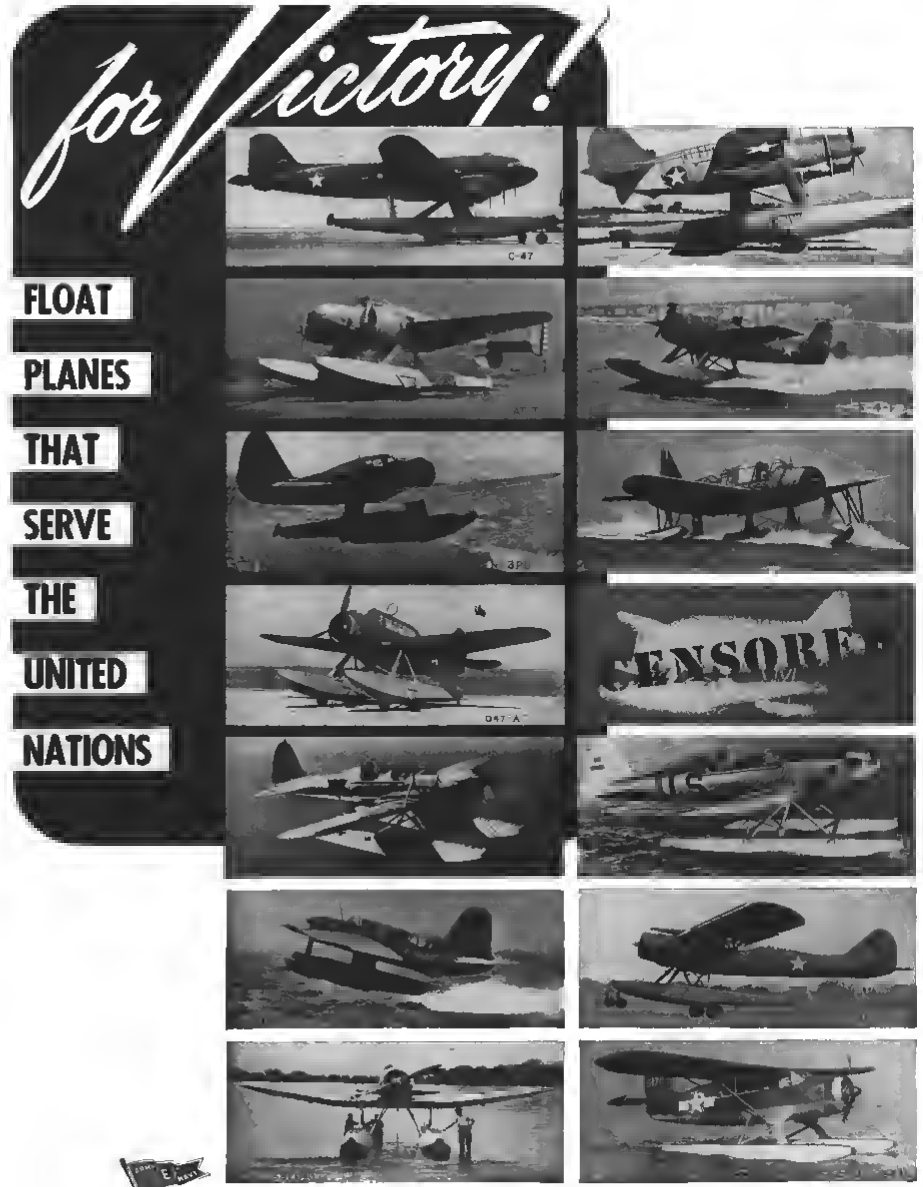
Remember, the usefulness of these rugged Mariners will not end with the war. Their stout construction, long range and complete dependability make them ideal for tomorrow's overocean airlines. Keep your eye on the Martin Mariner, after Victory! THE GLENN L. MARTIN CO., BALTIMORE 3, MD. THE GLENN L. MARTIN-NEBRASKA CO., OMAHA.



Martin AIRCRAFT

Builders of Dependable Aircraft Since 1909

HOLD IT, MISTER! Don't cash in those War Bonds! Because each War Bond you cash in *doubles* Uncle Sam's job . . . gives him the duel task of selling bonds to carry on the war and selling bonds to replace those cashed in! Hang on to those War Bonds!



EDO AIRCRAFT CORPORATION, SECOND STREET COLLEGE POINT, N. Y., U.S.A.

A MODERN INDUSTRIAL MIRACLE

BY WILLIAM B. ZIFF

On the tenth anniversary of the founding of Bell Aircraft Corporation, the publisher of "Flying" tells of the production record at the Bell Bomber Plant, at Marietta, Ga.

"'THREE hundred Superfortresses bomb Japan's mainland.'

"Who would have believed, just after Pearl Harbor, that such punishment could have been meted out in less than three years' time?

"Yet it was only a few days after Japan's sneak attack that Bell Aircraft was notified by the Army Air Forces that the company had been selected to be a major builder of these giant, Boeing-designed B-29's in a plant to be constructed near Atlanta.

"The construction story of this giant aircraft factory, and its production achievements, form one of the industrial miracles of the war. In eight months after taking occupation of the plant, in early 1943, the first two Bell bombers were towed out for the test flights.

"How large is this plant? Well, imagine, if you can, nearly two Empire State Buildings laid end to end inside the main building. Under its roof there would be room for twenty of the world's largest battleships with enough vacant space for sixty-nine submarines and twenty-four PT boats.

"The B-29 production records being set up by the Bell Bomber Plant are naturally a military secret. But it can be said that production is on schedule and that the schedules have been substantially increased.

"And the mass attacks being made daily by these giant battleships of the skies are conclusive evidence of the teamwork that exists between Bell management and the thousands of Bell employees and the men of the U. S. Army Air Forces.

"The record of the company is clear on the eve of its tenth anniversary. Bell has pioneered in many aircraft developments which have contributed greatly to the war—P-39 'cannon on wings', the first American jet propelled airplane, the P-63 Kingcobra, the Bell helicopter, and the operation and management of this great factory which is the South's industrial miracle of this generation.

"In the coming decade, look to the Bell Aircraft Corporation to continue to be the pacemaker of aviation progress."

★ *Buy War Bonds and Speed Victory* ★

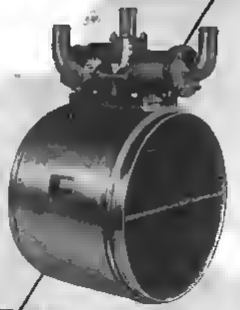
HARRISON TEMPERATURE ENGINEERING

THESE products represent the contribution of Harrison Temperature Engineering to the performance of military aircraft.

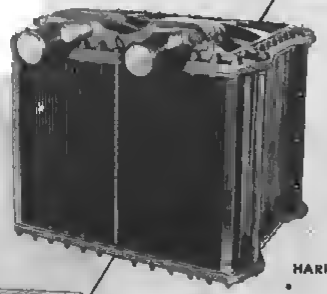
Together, they have "put heat in its place" in plane operation . . . solved the varied problems of heat dissipation and temperature control under conditions of flight ranging from sea level to stratosphere.

Each Harrison product benefits by intensive research carried on in Harrison's Aviation Testing Laboratories, where designs are tested and proved under simulated flight conditions. Weight has been reduced, durability improved and efficiency increased on the basis of these tests.

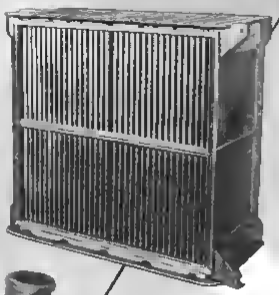
Harrison Temperature Engineering is qualified to meet all requirements of the aircraft industry for dependable heat transfer products.



HARRISON AIRCRAFT OIL COOLERS AND VALVES



HARRISOH AIRCRAFT RADIATORS



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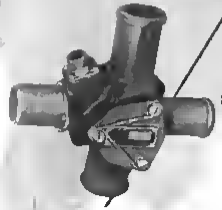

HARRISON DIVERTER VALVES

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OIL COOLERS • CONTROL VALVES • RADIATORS
DIVERTER VALVES • SUPERCHARGER INTERCOOLERS

Back Victory in the Pacific • Keep Buying War Bonds

HARRISON RADIATOR DIVISION OF **GENERAL MOTORS,** LOCKPORT, NEW YORK

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Snow is no respecter of delivery dates. It may strike while you're waiting for equipment ordered "too late." Play it safe. Get your orders in early and be ready for the first blizzard.

Send today for details on Walter Snow Fighters—the fastest method of runway clearing. Study their engineering, their construction details, their record at other airports. Work with Walter snow removal experts in planning your program. A headstart now means fewer headaches next winter!

HOW WALTER 250 H.P. SNOW FIGHTERS BEAT BLIZZARDS TO THE PUNCH!

- Clear a 28 ft. width in one run—at 20-30 m.p.h.
- Throw snow far to the side, preventing the formation of dangerous snow banks.
- Power is not wasted in slipping, stalling or wheel-spinning because the exclusive Walter 4-Point Positive Drive delivers power to FOUR driving wheels according to their traction at any instant.
- Runways stay open throughout the worst blizzard—ready for action the instant visibility clears.

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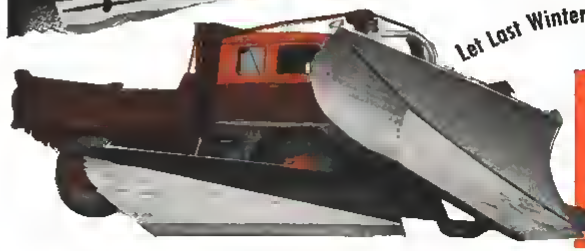
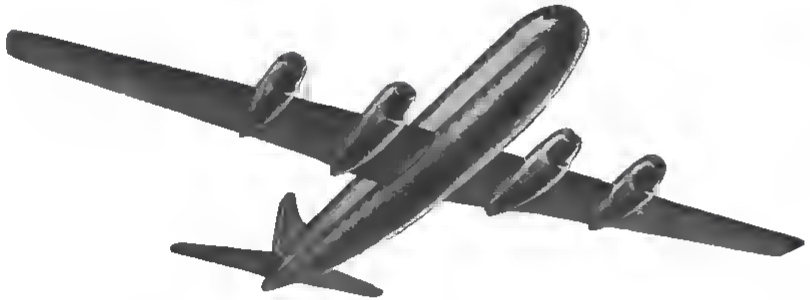


Let Last Winter's Lesson be Next Winter's Warning!

Order WALTER SNOW FIGHTERS Now!



BOEING STRATOCRUISER GETS

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FOR ELECTRICAL CIRCUIT SAFETY—

Designed for high speed, long range and low operating cost, the giant Boeing Stratocruiser is the first super-transport commercial air liner. Its pressurized cabin maintains 5000-foot altitude conditions up to 30,000 feet assuring passenger comfort. Other features include 3,500-mile operating range, 340 miles per hour cruising speed and large passenger capacity.

To protect the miles of electrical circuits from short circuits and overloads, Boeing engineers specified and used Klixon Aircraft Circuit Breakers. For, like the plane, these aircraft circuit breakers are built to give reliable operation under every flying condition.

Light in weight, compact Klixon Breakers trip out the circuit should internal troubles jeopardize the electrical system. Then when the trouble is remedied the pilot or engineer reestablishes the circuit by merely pushing a button. Klixon Breakers are foolproof because they contain no complicated fussy parts. Their accurate operation is unaffected by shock, vibration, altitude or motion. Harmless momentary overcurrents do not cause nuisance trip outs.

Protect the electrical circuits in your planes with Klixon Aircraft Circuit Breakers. Bulletins giving sizes, weights, dimensions and performance characteristics will be sent on request. Write for copies.

SPENCER THERMOSTAT CO., ATTLEBORO, MASS.

KLIXON

"KNOW HOW" in Gear Cutting

DESCRIPTION OF ILLUSTRATION

Cutting a 95-tooth, 4 pitch continuous tooth herringbone gear on large Sykes-type gear generator located in the Seattle plant of Western Gear Works. Angles of helicies, 20° 23 95° o d. Gear mates with a 27-tooth pinion. This machine is typical of over 150 standard and special gear cutting machines located in our four Pacific-Western plants.

How It Serves the Aviation Industry

Designing and cutting gears for the aviation industry for over 50 years gives Western Gear Works and Pacific Gear & Tool a "know how" unrivalled in the west. This "know how" goes beyond the knowledge of cutting gears to an intimate knowledge of the gearing needs of the aviation industry. Our engineers have broad experience in the details of load capacities, operating conditions, and space requirements of your industry, assuring you of gears and geared machinery designed specifically to solve your transmission problems. Phone or write our nearest plant.

PACIFIC-WESTERN GEAR PRODUCTS

Buy Fire Protection from the drafting board...

...and not off the shelf!

Larger, more powerful engines, and more of them per plane ... more complex designs...higher rates of air flow—these fast-moving trends have outmoded the once-effective "standard" fire extinguishing system of prewar days. ¶ Today, the carbon dioxide gas must pack a bigger fire-fighting wallop. Faster cylinder valves are needed to discharge the full volume of fire-fighting gas in 2 seconds flat. Multi-directional valves are called for. ..to put the gas into action on multi-engined power plants. ¶ These are just a few of the factors involved in the design of modern fire protection — protection that's *engineered for the plane!* ¶ There's no simple rule-of-thumb, no *one* answer to all fire protection problems. But there *is* one source of the right answer for each plane design. It's the fire-protection know-how of Kidde engineers—specialists in the application of gases-under-pressure to aircraft service. Kidde's design skill and application experience are ready to serve you ..just drop a line to our Product Development Department.

The word "Kidde" and the Kidde seal are trade-marks of Walter Kidde & Company, Inc.

Walter Kidde & Company, Inc. • 140 Cedar Street, New York 6, N. Y.

TO THE *GEAR USERS* OF AMERICA

Little enough credit has been given the GEAR MAKERS of America for their outstanding contribution to the Gear Industry. Without the consistent, refined accuracy in todays gear construction, "pin-point bombing", "maneuverability", "rapid acceleration", and other overworked trade expressions would still be words instead of actualities.

Achieving this consistent precision requires a constant vigilance over production operations and many leading gear manufacturers have designated Vinco Dual Purpose Gear Rolling Inspection Fixtures—coordinated with Vinco Master Gears, as an essential to successful inspection control. The dual purpose fixture, as the name implies, has the important advantage of checking both the run-out and backlash of the part gear with one Vinco master gear; a Vinco feature that saves time, cuts operating costs and increases production. For a more detailed description write for BULLETIN NO. 91.

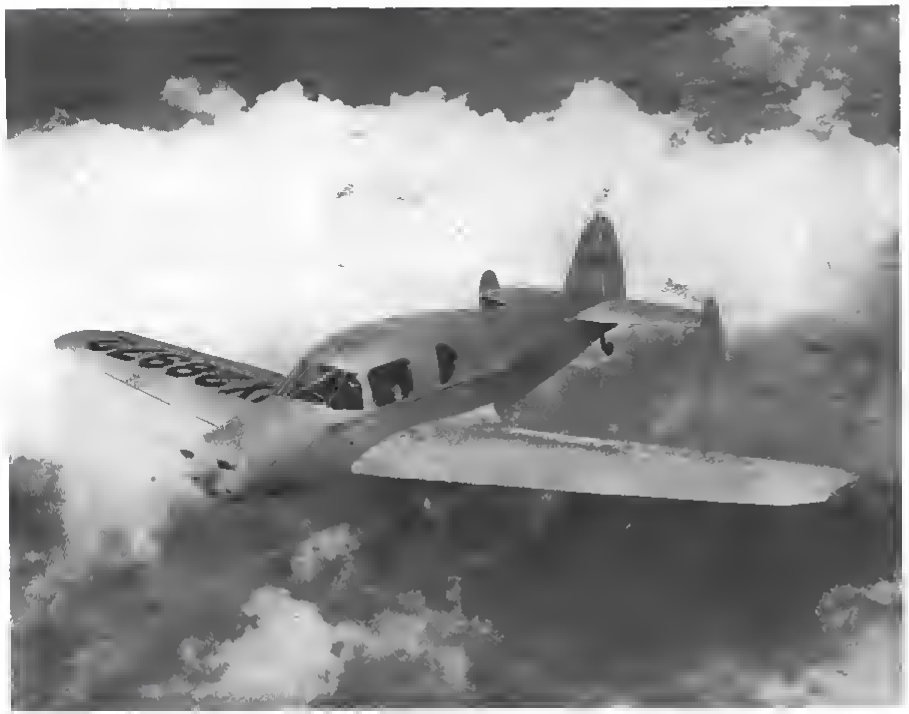
MILLIONTHS OF AN INCH FOR SALE BY VINCO

VINCO CORPORATION 8865 SCHAEFER HIGHWAY, DETROIT 27 MICHIGAN SALES OFFICES, NEW YORK, CHICAGO, CLEVELAND

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Hub Gages • Built-up and Special Gages • Gear Rolling Fixtures • Spline and Index Fixtures • Hydraulic Power Control Utilization and Distribution Units • Engineering, Design and Development

AMERICA'S 1946 ECONOMY PLANE

The new 1946 Bellanca Cruisair will be one of America's first family planes to reach new owners. This easy-to-fly economy plane, during the past five years, *has established its extreme fuel economy at 22 to 25 miles per gallon.* Even the proved performance and dependability of the original Cruisair will be exceeded by the additional war-developed efficiency features of the new 1946 Cruisair. Soon we can mail you complete illustrated specifications and delivery plans. Meanwhile, be sure to have your name and address on file at Bellanca headquarters. . . . Bellanca Aircraft Corporation, New Castle, Delaware.



Hans Groenhoff Photo

BELLANCA *Cruisair*

LIGHT landings for HEAVYweights!

To help make safe landings, giant transport planes, such as the Constellation illustrated, are equipped with AEROLS (Cleveland Pneumatic shock absorbing landing gear). By protecting plane, crew and cargo, AEROLS contribute substantially to aviation's progress—as planes grow in size, weight and speed, AEROLS help solve their landing problems. ✦ Our major products, used in many industrial fields, are mentioned below. Whatever your needs, Cleveland Pneumatic engineers offer you the benefit of over 50 years manufacturing experience.

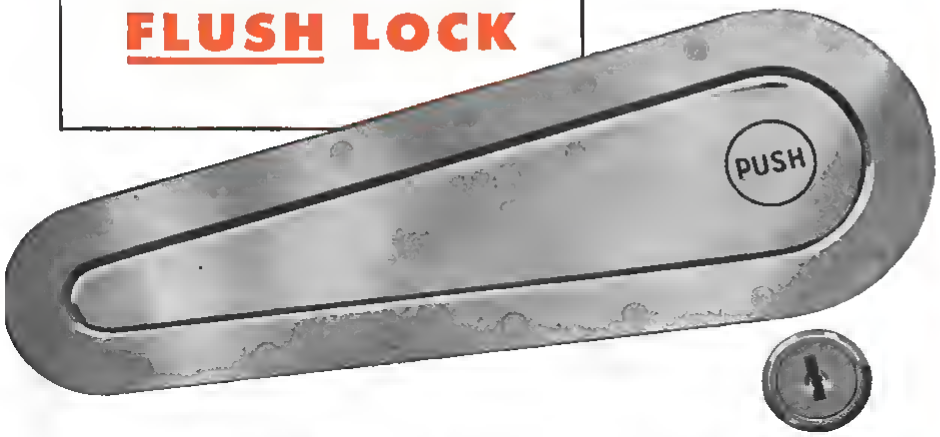
THE CLEVELAND PNEUMATIC TOOL CO., Cleveland 5, Ohio

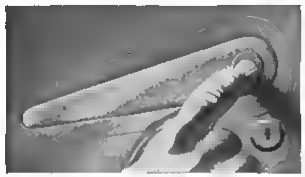
Speed Final Victory! Buy MORE War Bonds

Streamline your new plane doors

with the

HARTWELL FLUSH LOCK





Press to release. The spring that slides the handle forward from the closed position is released by push button. When extended, the *tear drop* handle provides a firm, convenient grip. The key lock shown above is an optional item.

Easy to operate. Only a minimum amount of pressure is needed to operate the handle. The first 45° movement of the handle actuates the rotating wedge mechanism. The next 17° movement retracts the spring-loaded, safety catch bolt.

Designed for use on all types of aircraft doors, including pressurized cabins, the new Hartwell Flush Door Lock gives your plane that final streamlined touch. The *tear drop* handle recesses into the door, presenting a smooth, flush surface. A push button release slides the handle forward with ample clearance for easy operation.

Wedges and spring-loaded, safety catch bolt are actuated by either the outer or inner handle. Minimum thickness of doors in which the lock can be installed is 1⅞", and minimum over all depth—handle to handle—is 3".

The Hartwell lock is *a basic lock!* It can be tailor-made to meet individual requirements. For detailed information write Chief Engineer, Hartwell Aviation Supply Company.

Single source for 779 different aircraft production parts and tools

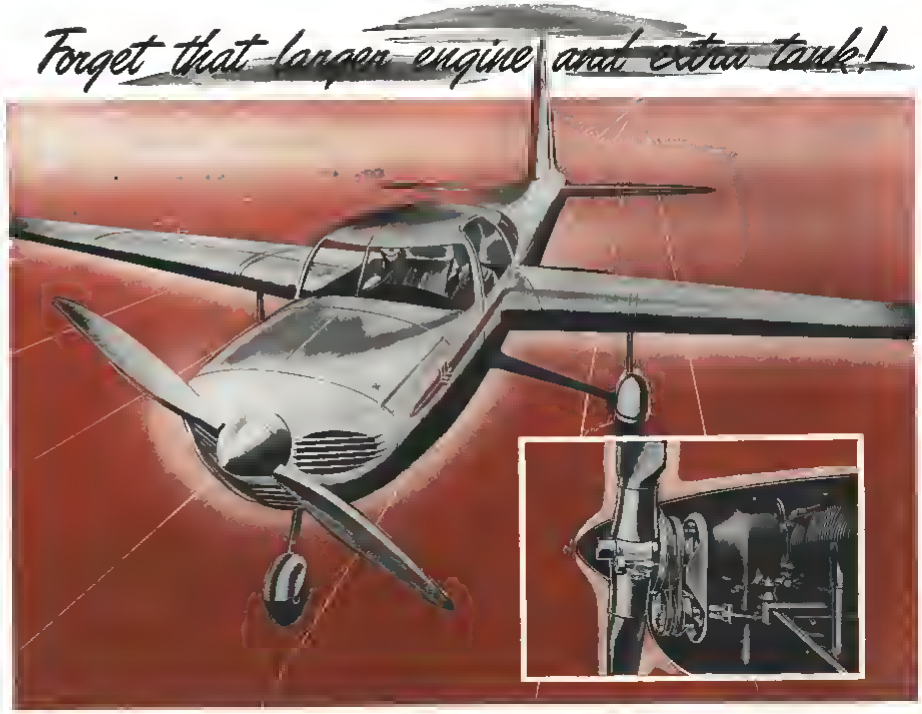
HARTWELL

AVIATION SUPPLY COMPANY

3417 Crenshaw Boulevard, Los Angeles 16, Calif.

Dallas, Texas • Kansas City, Kansas

Forget that larger engine and extra tank!



ISO-REV

CONSTANT SPEED

propellers

As shown by their exclusive use on high performance military and commercial aircraft, *selective rpm constant speed propellers* have superseded other types. They permit maximum utilization of available horsepower and optimum aerodynamic propulsive efficiency.

Only the unique operating principle of the *ISO-REV Constant Speed Propeller* inexpensively brings the many advantages of *true constant speed* operation to the personal airplane. Its application is equivalent to the installation of a larger engine and extra fuel tanks.

A booklet describing the principle of ISO-REV operation is yours for the asking

"ISO—equal, alike, the same, uniform"

AIRCRAFT SPECIALTIES DIVISION

THOMSON INDUSTRIES, INC.

Formerly Named ZIMMER THOMSON CORPORATION

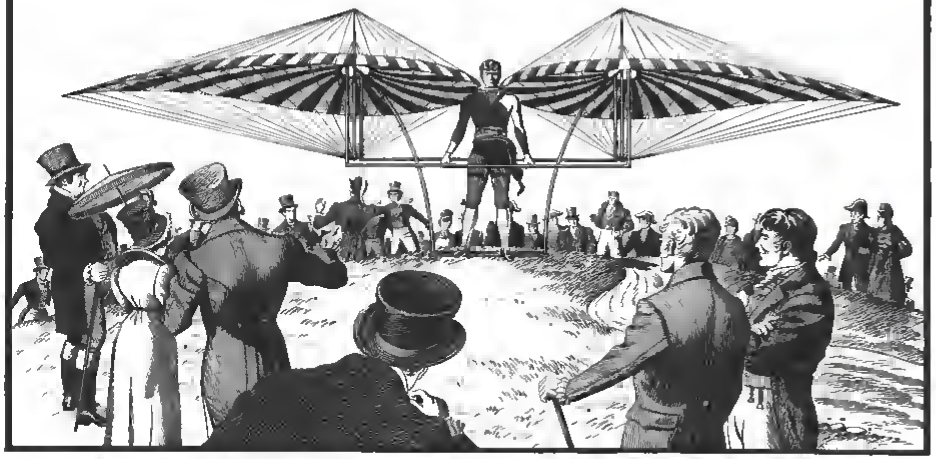
29-05 Review Avenue, Long Island City 1, New York

With Umbrella Wing's

pioneer Jacob Degen sought LIFT enough to fly

(1808 A.D.)

Pictured here is the "Flugmaschine" as exhibited by the Viennese, Jacob Degen, between 1808 and 1812. The wings (each 8½ x 22 feet) were covered with strips of taffeta attached to a central stick. Thus, when moved, fluttered the strips to imitate the wing feathers of a bird.



LIFT is what takes an airplane off the ground. *Drag* is what fights against a plane's flight. The struggle first to fly at all, now to fly ever faster and farther and higher on less and less energy, is a struggle of Lift versus Drag.

In that struggle, during the last twenty years, men of the Northrop group have written many records, achieved a notable number of "firsts."

In 1929, for example, the first of the Northrop Flying Wings successfully flew. The Flying Wing, mind you, is the first airplane in which all elements contribute to *Lift*—the first design that is free from the Drag of conventional fuselage. Later Northrop designs have eliminated the entire conventional tail assembly, provided rudder action within the wing itself.

The first "over-weather laboratory," the plane which made experiments leading to today's high altitude flying, was a Northrop "Gamma" (1934). Most recently, Northrop perfected the first retractable ailerons which permit full-span wing flaps, provide a combination of tight turning ability and slow landing speed in a large, fast airplane.

Other triumphs of Lift over Drag are ahead. Working toward them the Northrop group may be expected to design and build airplanes for tomorrow's peacetime needs. Planes that will fly further on less fuel, with more payload than the planes of today. Northrop Aircraft, Northrop Field, Hawthorne, California

NORTHROP

Creators of the ***Black Widow*** *P-61 Night Fighter and the* ***Flying Wing***

When it's *Dusting Time* in DIXIE

When cotton "squares" begin to form in early summer . . . it's *dusting time in Dixie*. For it is at that stage in the growth of cotton, that the *boll weevil* begins to get in its deadly work.

That's why each plant must be dusted with a chemical preparation which kills the boll weevil, and prevents the growth of millions of tiny grubs which eat the heart out of the cotton.

Dusting may be done by hand, mule or tractor drawn machines, or by airplane. The technique of dusting by plane has proved equally effective against the army worm, and other insect pests which attack cotton at various stages of its growth. Fruit trees too, may be treated by air.

Another application of importance to cotton growers, postwar, will be aerial dusting as an aid to *mechanical picking*. In this process, called "defoliating," *cyanamid* is dusted over plants a few days prior to picking, causing unopened bolls to open and leaves to drop off.

Further development of the *helicopter* promises to bring great efficiency to the technique of aerial crop dusting. Its use at low speeds will permit more thorough dusting of individual plants, and its ability to hover, to fly forward, backward, and sidewise, to make vertical ascents and descents, will permit its operation close to obstructions where fixed wing airplanes could not be used.

Operated by professional pilots, the applications of the helicopter for commercial uses, postwar, are almost endless. And since it needs neither rails, roads, nor special landing facilities, its cargo carrying costs on a *ton-mile* basis to inaccessible points—are almost unmatchably low.

At McDonnell, *right now*, our main job is to turn out more planes, parts, and plastics for war—to hasten victory.

But after *complete* victory has been won, we shall look forward to the privilege of telling you and showing you how and where the helicopter can serve your specialized needs . . . for almost any type of commercial use . . . almost anywhere in the world.

During the decade just prior to World War II, the United States produced more than 40% of the world's cotton. Dusting is the most effective means for combatting cotton's worst enemy—the boll weevil.

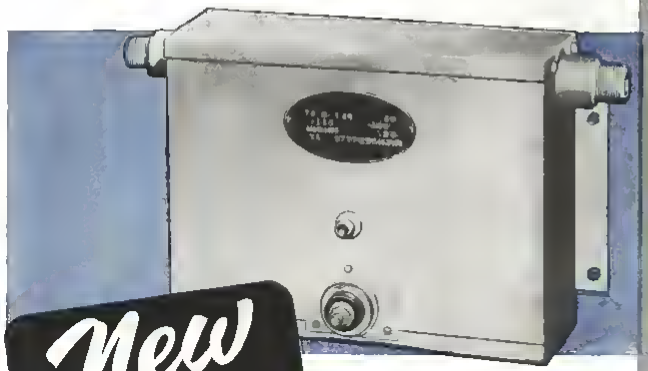
McDONNELL *Aircraft Corporation*

Manufacturers of PLANES · PARTS · PLASTICS * SAINT LOUIS - MEMPHIS *

POWER

for aircraft cabin heaters and de-icers

WITHOUT RADIO INTERFERENCE



New 400-cycle, G-E ignition transformers that provide an unfailing 6000-volt arc

LIGHTWEIGHT: 13 pounds for largest rating (illustrated)

SMALL: Approx 10½ by 3¾ by 6¼ inches for largest rating (illustrated)

HIGH OUTPUT: 6000-volt secondary at 20 ma

Lighter and more compact than standard, 60-cycle oil-burner units, these ignition transformers for gasoline-fired cabin heaters and de-icers are designed to withstand the most severe flying conditions. They operate from a 115-volt, 400-cycle power supply, and deliver ample output current for positive and continuous ignition. Ordinary operating hazards—such as cold or fouled spark points—do not affect the efficient operation of these units. A new and improved method of shielding and filtering provides exceptional freedom from radio interference over all wave bands from 10 kilocycles to 200 megacycles.

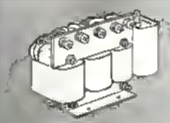
Three ratings available—One has a single secondary for use on circuits where both primary leads must be insulated from ground; each primary lead is provided with a filter.

Another unit (illustrated) has a double secondary for application on heaters with dual ignition, or for use with two separate heaters having single-ignition systems, one side of the primary is grounded. The third unit has a single secondary, and differs from the first unit in that one side of the primary line is grounded; thus, it requires only one primary filter, reducing the weight by 2¾ pounds. All units have a power factor of 90 to 95 per cent.

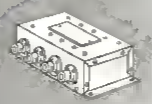
Wide range of operation—These new transformers are designed to resist moisture, heat, vibration, shock, and corrosion. They will operate successfully at any ambient from −70 to 140 F, at any altitude up to 45,000 ft.

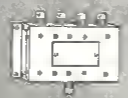
For further information, ask for Bulletin GEA-4431. Or, for data on our complete line of aircraft transformers, write for Catalog GEA-4238. *General Electric Company, Schenectady 5, N. Y.*

IMPROVE AIRCRAFT ELECTRIC SYSTEMS WITH THESE G-E TRANSFORMERS



3 to 1-phase, 2 to 3-phase, and 1 to 3-phase transformers





Transformers and ballasts for lighting indicators and instruments

Starting vibrators and ignition boosters

FOR THE WAR PLANES OF TODAY and THE COMMERCIAL PLANES OF TOMORROW

GENERAL ELECTRIC

I'll be the Crew, and the Pilot, too!

1. When the war's over, I'm buying a plane of my own with some of the dough I've saved. (It doesn't take much.) I may pick the Chief, with its high wing design—or the Eagle, with room enough to carry the family on a hunting and fishing party just about the way you'd take them in a car. Or maybe . . .

2. One of the other models they're still testing in the wind tunnel. Aeronca got the savvy out of war work, added to more than 16 years of experience before that. They're all out for war now. That's why they've won the Army and Navy "E"—and they're the only light aircraft company to get it. They'll have postwar models with features you've never thought of before.

3. They've even prepared booklets that answer many of the questions related to centrally located airfields, and service and gas and oil. There's also an Aeronca book that tells about the new planes. There's nothing to stop you from sending for them both. Use the coupon!

AMERICA'S PERSONAL PLANE

AERONCA

has an important message for air-minded people

Department A-7
Aeronca Aircraft Corporation, Middletown, Ohio
Send me your valuable booklets.
(Check)

_____ "Aeronca—The Plane You'll Want To Fly"
_____ "Why You Should Be An Aeronca Dealer"

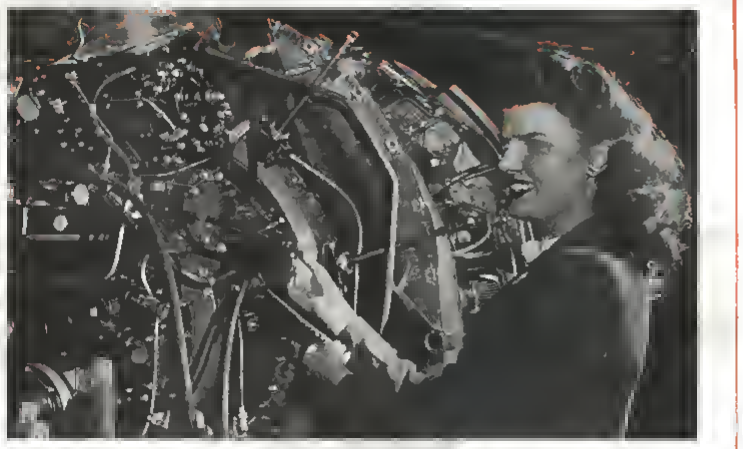
Enclosed is 18c for each booklet.

Name _____

Address _____

City and State _____

Export Agency—Aviquipo, Inc., 25 Beaver Street, New York 4, N. Y.



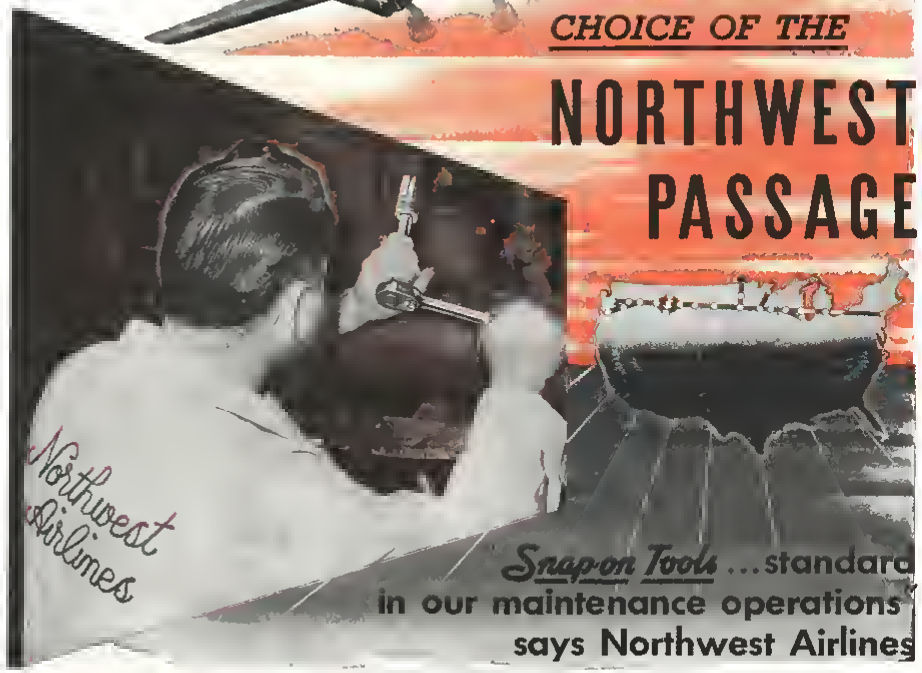
FLEX-O-TUBES Help B-29's DELIVER BOMBS TO TOKYO

The big superfortresses carry Flex-O-Tube hose assemblies in air pressure lines, oil lines, fuel lines and hydraulic lines. These ships can travel faster, higher and farther than any other heavy bomber in the world. Flex-O-Tubes are trustworthy.

THE **Flex-O-Tube** COMPANY

LAFAYETTE at 14th AVE., DETROIT 16, MICHIGAN
Offices: CHICAGO · FORT WORTH
LOS ANGELES · NEW YORK
SEATTLE · TORONTO, ONT.

CHOICE OF THE NORTHWEST PASSAGE



Snap-on Tools ...standard in our maintenance operations says Northwest Airlines

TOP FLIGHT across America . . . a swift, direct route between Atlantic and Pacific . . . with its extension of service to Detroit and New York, Northwest completes the nation's fourth great coast-to-coast airline!

In the maintenance operations of Northwest Airlines, Snap-on tools have long played an important part. "As America's second oldest air transport company Northwest was necessarily a pioneer in developing many advanced maintenance practises," says Northwest Airlines . . . "and Snap-on tools have met our most rigid requirements. From the start Snap-ons have so conclusively demonstrated their superior speed, accuracy and adaptability that they have become standard in our maintenance operations."

Snap-on's nation-wide tool service is available through 38 factory branch warehouses. Write for the 1945 Snap-on catalog.

SNAP-ON TOOLS CORPORATION, 8020-G 28th Ave., Kenosha, Wis.

It is reported that . . . . . .

One of the obstacles in the way of large-size home television is the cost of the necessary aspherical lenses. A new material and method makes it now possible to mold these accurately of plastic at much lower cost. *Polaroid Corp.*

get ready with **CONE** for tomorrow

A "plastic foam" has been developed that is semi-rigid and weighs only about one-seventh as much as cork.—*U. S. Rubber Co.*

get ready with **CONE** for tomorrow

A western college is preparing courses in the management of small business, particularly for returned veterans. *Western Reserve University.*

get ready with **CONE** for tomorrow

Before the war we imported about one million glass eyes from Germany. Now an American manufacturer is reported to be filling a Russian order for 50,000 plastic eyes and to promise them for the use of our civilians later in the year. *American Optical Co.*

get ready with **CONE** for tomorrow

Three coal companies and six railroads are to collaborate in a million dollar research program to improve the coal burning locomotive. *Bituminous Coal Research, Inc.*

get ready with **CONE** for tomorrow

An automobile manufacturer is expected to enter the farm market with a number of new tools including a modified flame thrower for killing weeds. *Graham-Paige Corp.*

get ready with **CONE** for tomorrow

A new electronic piston ring inspection instrument uses beams of light to check accuracy within 0.001 inches in less than five seconds. *Sheffield Corp., Dayton.*

get ready with **CONE** for tomorrow

A new process claims to be able to electroplate aluminum with any of the conventional plating metals. *Alumon Euthone Co., New Haven.*

A new glass resists heat up to 1650 degrees Fahrenheit. *Vycor—Corning Glass Works.*

get ready with **CONE** for tomorrow

A new Diesel engine burns natural gas, coke-oven gas or sewage gas, as well as oil, without shutting down to exchange parts. *Cooper-Bessemer Corp.*

get ready with **CONE** for tomorrow

A new anodizing process makes magnesium resistant to corrosion. *Consolidated Vultee.*

get ready with **CONE** for tomorrow

The craft of gem cutting is being taught in this country to returned veterans in an effort to hold the advantage in this field that the war has given us. *Gabriel Williams, N. Y.*

A 96-pound bearing produced by powder metallurgy is claimed to be the largest of its type yet made. *Chrysler Corp., Amplex Div.*

get ready with **CONE** for tomorrow

The first direct drive steam turbine locomotive to be built in the United States is undergoing tests to determine its adaptability to long-distance high-speed freight and passenger service. It is said to be capable of pulling a passenger train at 100 miles per hour. *Penn. RR Baldwin Locomotive Works—Westinghouse.*

get ready with **CONE** for tomorrow

A photographic technique is claimed to be so sensitive that it will record even differences in air pressure such as shock and sound waves or air jets. *Schlieren Method—General Electric.*

get ready with **CONE** for tomorrow

A new dynamometer can stop a 158 ton wheel, whirling 3 miles per minute in 18 seconds. *Westinghouse.*

Planning Today, For The Planes That Will Fly Tomorrow

Wolf's Head chemists and laboratory research men are literally looking over the shoulder of airplane designers as the planes of tomorrow take shape on the drafting board. What characteristics must aviation oil have to meet the demands of these designers? Wolf's Head engineers will find the answer.

Since the earliest days of aviation Wolf's Head has never lost step with the development of aircraft engines. As these engines grew more powerful, as lubrication needs changed with each new forward step in aircraft development, so Wolf's Head kept pace.

Wolf's Head Aviation Oil has won and held the approval of aircraft engine designers and builders for its matchless quality. Today it is the aviation oil used by leading aircraft engine manufacturers for critical test and break-in runs. It is known by ground crews around the world. Whatever developments take place in the planes that will fly tomorrow, Wolf's Head 100% Pennsylvania "finest of the fine" will be ready to meet their requirements.

Wolf's Head Oil Refining Company, Oil City, Pa.—New York 10, N. Y.

WOLF'S HEAD

100% PENNSYLVANIA AVIATION OIL

P.G.C.O.A. Permit No. 6

"For Over Half a Century Wolf's Head Has Been Recognized as an Outstanding Leader in the Production of Extra Fine Automobile Oils and Lubes"

What's going to happen to the SUZY Q?

Remember the graveyard of rusting ships after the last war? For years a grim reminder of surplus war production, they also represented a practically bankrupt shipbuilding industry.

Today, America's aircraft industry accounts for a substantial proportion of our total national economy. That industry has produced more than a quarter of a million planes since Pearl Harbor! Its plants, equipment and production represent 50 billion dollars worth of taxpayers' money.

Here is the most valuable single peacetime legacy of war. . . . Here is power to maintain peace, insure our national security and provide jobs for millions of Americans . . . And here is a critical problem.

For the percentage of profit earned by our aircraft industry is so low that its entire capital reserves amount to only a few days' operating costs! The lack of a sound national airpower policy could actually result in the collapse of a great industry and the promise it holds for the whole world.

We at Bryant know that we can sell many machine tools to a healthy peacetime aircraft industry. But far more important — those tools mean jobs, and our last chance to enforce peace throughout the world.

BRYANT CHUCKING GRINDER COMPANY SPRINGFIELD VERMONT, U.S.A.

4 TOUGH JOBS

. . . and how to lick 'em with G-E Mazda Lamps

Proper use of better lighting can produce startling results . . . in better efficiency, in reduced spoilage, in more and faster production. Shown here are four typical industrial jobs, each much improved with better lighting from G-E Mazda Lamps. Ask your G-E Lamp Distributor for full details.

1 **Instant detection** of breaks in fine wire helps this plant keep production up, costs down. Correct lighting with G-E Mazda Lamps enables even unskilled workers to reduce errors and do more accurate work

2 **Polished surfaces** often present tough inspection problems. Above, inspection of highly polished machine parts is made easier with low brightness, high footcandle lighting developed with G-E Mazda Lamps

3 **Safety hazards** can be minimized with high level illumination. G-E Mazda Lamps provide uniform, efficient light sources to help operators see better, faster, more accurately.

4 **Fewer mistakes!** G-E Fluorescent lighting helps to hold skedaws at an absolute minimum. It approaches actual daylight conditions with soft, cool, low-brightness illumination.

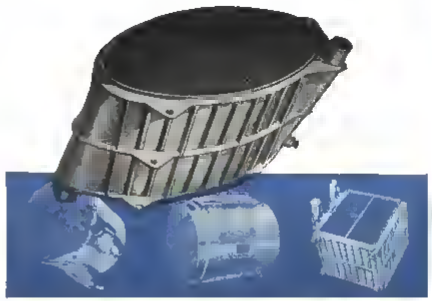
"To make G-E Lamps STAY BRIGHTER LONGER"
The constant aim of G-E Lamp Research

G-E MAZDA LAMPS

GENERAL ELECTRIC

Hear the G-E radio programs: "The G-E All-Girl Orchestra", Sunday 10:00 p. m. EWT, NBC, "The World Today" news, Monday through Friday 6:45 p. m. EWT, CBS, "The G E Houseparty," Monday through Friday 4:00 p. m EWT, CBS.

BUY MORE WAR BONDS . . . AND HOLD 'EM



DESIGNERS WELCOME ALUMINUM BRAZING

Before discovery of the way to braze thin aluminum tubes intimately to aluminum header plates and shells, designers of heat transfer units were limited to use of copper in conventional shapes unless they reinforced the structurally-weak copper. That's because soft solder used with copper — even at its best relatively low in resistance to temperature, pressure, vibration and shear — can't stand the uneven stresses resulting from departure from conventional shapes.

NOW DESIGNERS HAVE NEW SCOPE

Clifford's discovery of aluminum brazing gives designers greater scope in planning the shape of heat transfer equipment. That's because.

1. All-aluminum units save ⅔ the weight of copper in the same size and shape.
2. Heat-treatable aluminum alloy tubes stand up under temperatures which gradually anneal and weaken copper.
3. Aluminum alloy brazing material is several times higher in resistance to temperature, pressure and strains than soft solder

So it's easy to see why USAAF designers gave several shapes of Clifford Feather-Weight Oil Coolers and Coolant Radiators a chance to make good in several types of aircraft.

LOOKING AHEAD

Right now Clifford's production is devoted exclusively to war work, but inquiries and suggestions about post-war automotive, heating, cooling and vantdating applications of all-aluminum heat-transfer units will be welcomed. *Clifford Feather-Weight . . . Save ⅔ the weight . . . same size and shape.* Clifford Manufacturing Co., 561 E First St , Boston 27, Mass

IN HYDRAULICALLY-FORMED BELLOWS alloys are chosen with care

Pure metals and many alloys are unsatisfactory for bellows because they lack the necessary spring properties when cold-worked.

A hydraulically-formed bellows — made by forcing a cold tube between the plates of a collapsible metal die by internal hydraulic pressure — requires a metal of good deep-drawing properties and reasonable resistance to corrosion.

80-20 BRASS IS BEST

A brass consisting of 80% copper and 20% zinc is the best alloy because it has excellent deep-drawing properties, is not readily subject to "season cracking", receives required spring-action from cold-working.

PHOSPHOR BRONZE ALSO GOOD

Next in importance is phosphor bronze containing essentially 95% copper and 5% tin. It has properties similar to brass and is more resistant to corrosion Being higher in cost, it is restricted to specialized cases

SPECIAL ALLOYS AVAILABLE

Where resistance to corrosion is more important than resistance to mechanical fatigue, copper-nickel series alloys have been successfully used for bellows in hot water systems and high pressure steam devices.

CLIFFORD HAS ALL THE FACTS

Clifford, first to produce hydraulically-formed bellows for industry, has kept abreast of progress in metals . . . and is therefore equipped to supply you with these uniform, pretested bellows in all practical alloys . . . either alone or in highly engineered assemblies. For proof that Clifford is *First with the Facts on Hydraulically-Formed Bellows*, write Clifford Manufacturing Co., 561 E. First St., Boston 27, Mass.

CLIFFORD *Feather Weight* **OIL COOLERS AND COOLANT RADIATORS**

HYDRAULICALLY-FORMED BELLOWS

This advertisement is one of a series now appearing in national magazines and newspapers as Consolidated Vultee's contribution toward a clearer public understanding of how and why America must retain its present Air Supremacy, even after Victory.

THE JOKER IN AIR POWER

EVERY PILOT who wings his Liberator or Fortress over Germany or Japan knows what the joker in Air Power is.

Every ground crewman whose job is to keep a Mustang, Thunderbolt, or Corsair in hair-trigger fighting trim knows what it is.

Every aircraft engineer who ever saw the inside of a wind tunnel knows what it is.

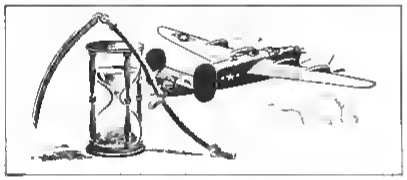
Do you know the joker in Air Power?

It's very important that you should **For, partly because America forgot it during the prewar years, we came terribly close to losing this war right at the start.**

But now we are winning this war, largely because a few far-sighted men knew what the joker in Air Power was.

So simple—so easy to forget

The joker in Air Power is TIME—the heart-breaking months and years it takes to design, to build, and to perfect a plane to the point where it becomes an efficient, service-tested battle plane, ready for action.



For example America's first four-engine, long-range bomber was born back in 1934.

But when war was declared, some 7 years later, this bomber was *not even then* ready to go into action as the potent fighting weapon it is today.

True, the first model was flown in the summer of 1935. The aircraft engineers knew then that the basic design was good.

But between the first "prototype" and the current model, **there have been more than 4000 changes, involving over 4 million engineering hours.**

Even by working with desperate speed, it has taken years to smooth out the "bugs"—to give our Air Forces this heavy long-range bomber, so urgently needed, in its most efficient form.

There aren't many short cuts

When the war clouds grew blacker over Europe, the U. S. Army Air Forces came to Consolidated Vultee with the request for still another four-engine heavy bomber.

Shortly afterward—in 1939—the B-24 Liberator was born.

But, even with Consolidated Vultee's long experience in building mammoth sea planes, **it took over 3 years, over 1 million engineering hours, and more than 5 million hours to tool up the plants,** before the Liberator was ready to go into action as one of America's most devastating, heavy bombardment weapons.

Similarly, it took 5 years to develop one of this war's foremost fighter planes from drawing board to final test flight and mass production.

And one of the country's greatest aircraft engines has taken **11 years** to develop—and ever since the war started, it's been undergoing change after change to increase its horsepower still more.

America 1941—a second-rate power

Many other examples could be cited. But there is no need to labor the point.

The truth of the matter is that America was caught napping. The nation which invented the airplane was woefully unprepared to defend itself against Axis air power. **We had become a second-rate power in the air.**

And the Axis knew it. They knew that under normal conditions, it takes from 3 to 7 years for a plane to progress from drawing board to combat duty.

What they overlooked was the undreamed-of capacity of the American people, and the American aircraft industry, to do the impossible.

Starting almost from scratch, we have been able to design, build, and deliver war planes by the tens of thousands—an air armada overwhelming in its might and superiority, *and today.* But remember, the elapsed time has been *five years!*

"Hot" today—obsolete tomorrow

But in aerial warfare, the nation that depends on mere quantity and present-day superiority of its planes cannot win. That is one reason why Germany lost the Battle of Britain in 1940.

Progress in aeronautics is now so rapid that today's "hottest" combat plane is virtually obsolete tomorrow. Its quality must constantly be improved—to keep it superior to the enemy's ever-improving planes.

And it must be replaced, with all possible speed, by new planes now on our drafting boards, in our wind tunnels, or undergoing their test flights.

These are facts which an alert America should not, must not, forget.

Another fact to keep in mind

If we are attacked again, there will probably be no warning whatever—no time to prepare.

There will be no other nation to hold off the enemy, as Britain did this time, while we frantically build up our power in the air.

And the attack will most certainly be made with new and even more terrible airborne weapons.

We must be ready, and able, to protect ourselves from such attack.

Air Supremacy alone cannot win a war, and may not in itself prevent *another* war. **But as long as we maintain our strength in the air, no aggressor nation in its right mind will dare think of attacking us.**

Air Power is Peace Power

The backbone of Air Supremacy is a strong, independent competitive aircraft industry, constantly working in research, in the improvement of production technique, and in the development of still finer planes.

But we must understand that Air Power is a combination of *all these things:* a postwar Air Force, commercial air transport, a strong supporting aircraft industry with permanent facilities to meet any emergency, widespread personal flying, and a national air-minded way of thinking.

When we understand this, we begin to realize that Air Power can be one of America's soundest investments in the interests of a lasting peace.

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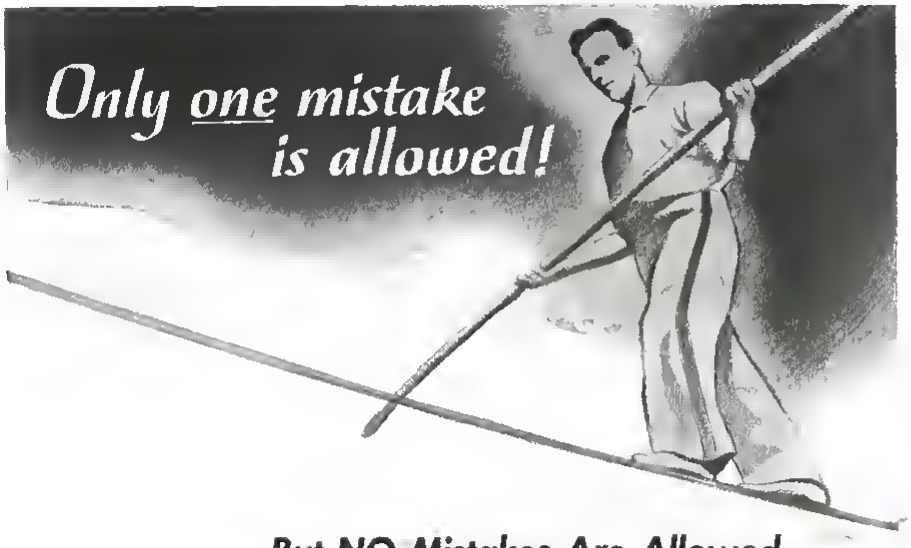

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THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

IMMEDIATELY after Pearl Harbor, the airlines gave up half their planes to a hard-pressed Uncle Sam. Then, as the tempo of war picked up and the nation demanded speed and more speed, the men and women who fly our sky routes turned in one of the greatest jobs in transportation history.

Working against terrific handicaps in shortage of equipment, the airlines carried more and more and more. Passengers and freight increased. The load ratio went from 59% in 1941 to an "impossible" 90% in 1944. Planes put in more and more hours per day . . . until many were flying eighteen out of twenty-four, and only perpetual overhaul kept them going.

Through three long, tough years, maintenance crews fought the battle of the monkey wrench to keep America's precious, time-saving handful of commercial ships in the air and on schedule. Month in and month out pilots flew them sweet and careful . . . nursed them for speed . . . hung up new safety records . . . delivered vital goods and people to keep the war effort running at an ever faster pace.

Today, with relief in sight, the airlines are pointing the way for postwar America and the world. Against high wartime operating costs, they recently announced rate cuts. Airline route mileage in U. S. is at an all time high of 62,937 miles. Freight carried is nearly four times the prewar load. Total passenger miles last year were nearly a billion higher.

If air transport can do such a tremendous job in the face of warborn shortages of personnel and equipment, what will it do in peace! With a great body of schooled pilots and mechanics to draw upon and available equipment of a quality, carrying capacity and operating efficiency that were scarcely dreamed of in the prewar days, the sky's literally the limit!

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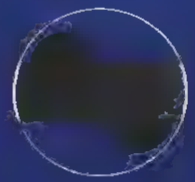

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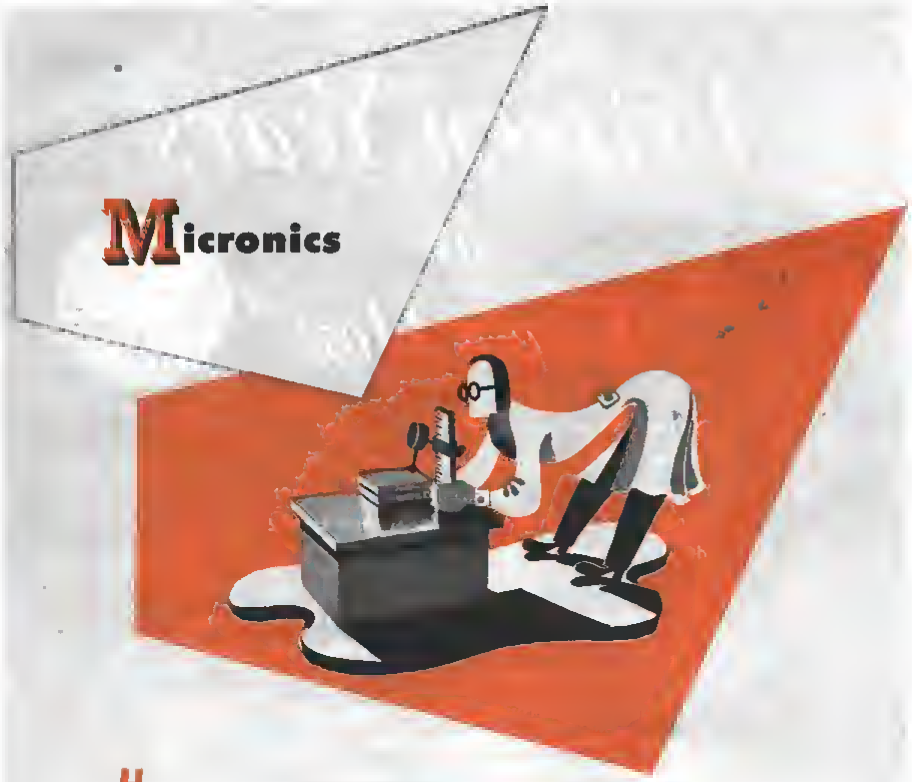

Hydraulics and electronics in aviation have come a long way. We're fortunate to have had a part in the development and improvement of both. But from where we stand, there are still places to go, things to do.

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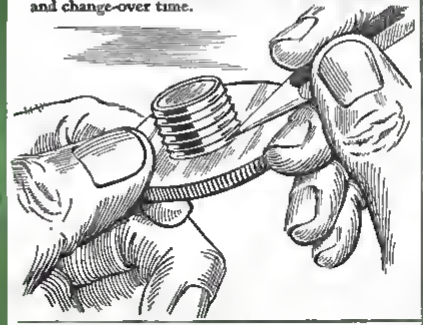
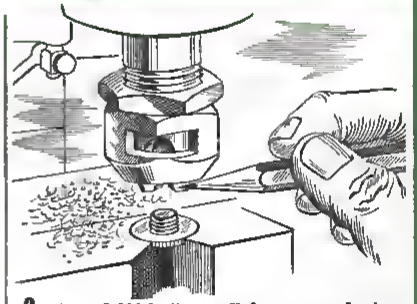
THREADING SMALL PART WAS HEADACHE . . . UNTIL "GREENFIELD MAN" SHOWED HOW WITH "ACORN" DIE

(A GTD SHOW-HOW REPORT)

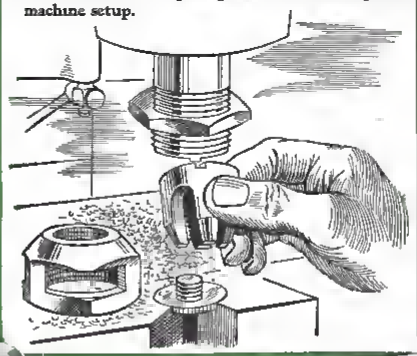
1 They were cutting an external thread on a zinc die casting. The thread length was only half an inch but it had to go to the bottom of the flange. The method in use would not deliver at high speeds, could not be adjusted quickly, required long setup and change-over time.

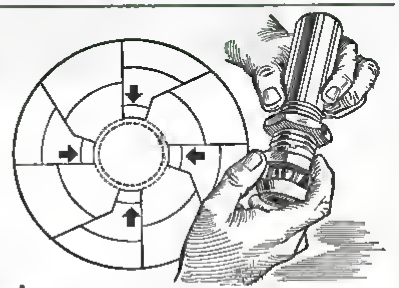




2 "Greenfield Man" was called in, suggested using an "Acorn" Die setup. Pointed out that "Acorn" Die allows threading as close to shoulder as desired since lands project out past the holder, (chamfered threads can easily be ground down by the operator or can be supplied already ground down).

3 He SHOWED HOW, by simply unscrewing the cap, the "Acorn" Die could be easily taken out of the holder for reharpening without disturbing the machine setup.





4 And finally, he pointed out how screwing on the cap compresses all four die lands to give a concentric adjustment. Accuracy of final adjustment is assured by the ground taper on the inner face of the adjusting cap which affords a perfect seat for the die lands.

Results: The customer's own words: "The job was very troublesome . . . but thanks to the 'Greenfield Man' the trouble was over when we used an 'Acorn' Die. The R. P. M. of the Die is 1100 on and 2200 off. Production has been stepped up to 1200 pieces an hour."

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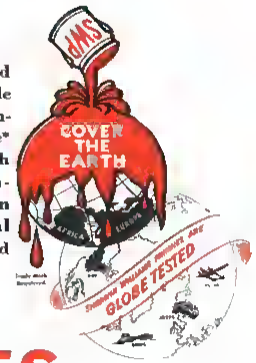

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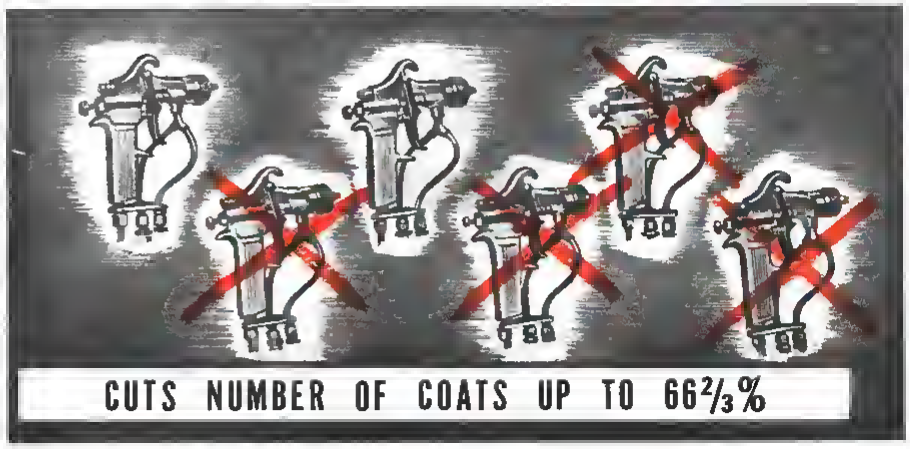

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save space and weight
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After old-type tube fairleads wore out the control cables between inner and outer skins or under the floor boards of planes, the aircraft industry tried pulleys. But pulleys of 2½" D. and up took too much space and too much precious weight . . . especially for cable bends shallower than ten degrees. This was a problem for specialists in eliminating friction. So these aircraft designers put it up to Fafnir as they had done successfully many times before.

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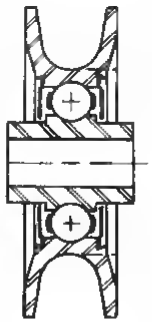
Of course, the doing was not that simple. Requirements of strength and lightness, of compactness and metal thicknesses had to be precisely balanced against each other to attain a design that would give greatest freedom from friction and keep wear on cables to a minimum.



Fafnir FL3C3 Fairlead Bearings for 3/32" cable, or smaller.

Fafnir FL3C6 Fairlead Bearings for 1/16" cable, or smaller.

Together with aviation engineers and designers, Fafnir reduced the problem to just two specialized ball bearings which will handle all standard aircraft cable . . . one about the size of a half dollar for 3/16" cable or smaller and the other about the size of a quarter for 3/32" cable or smaller. Both are shielded and prelubricated. Shields are stainless steel and other exposed surfaces are cadmium plated.

Just one more instance, in the growing list of aircraft-specialized ball bearings, of Fafnir leadership in bearing service to the aircraft industry. Data sheet on these Type FL (Fairlead) Ball Bearings is available on request. The Fafnir Bearing Co., New Britain, Connecticut.

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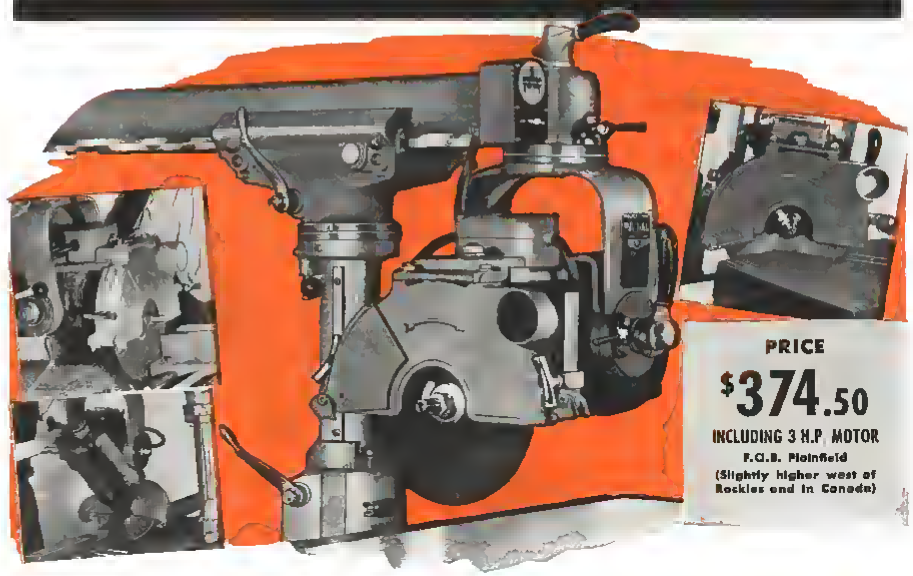

Walker-Turner METAL-CUTTING RADIAL MACHINE

The head on a Walker-Turner Metal-Cutting Radial Machine can be quickly set to cut at any angle. Cuts wide metal shapes. Will dado, trench, miter, even operate with motor in vertical position. Patented Walker-Turner Geared Motor is shockproof, gets shaft closer to work, makes deep cuts with smaller blades than in conventional motors. Blade feeds through work with shorter cutting arc and less frictional heat. Operator gets clear view of work, no interference from overhanging arm. Write today for complete information.

WALKER-TURNER COMPANY, INC., Plainfield, New Jersey

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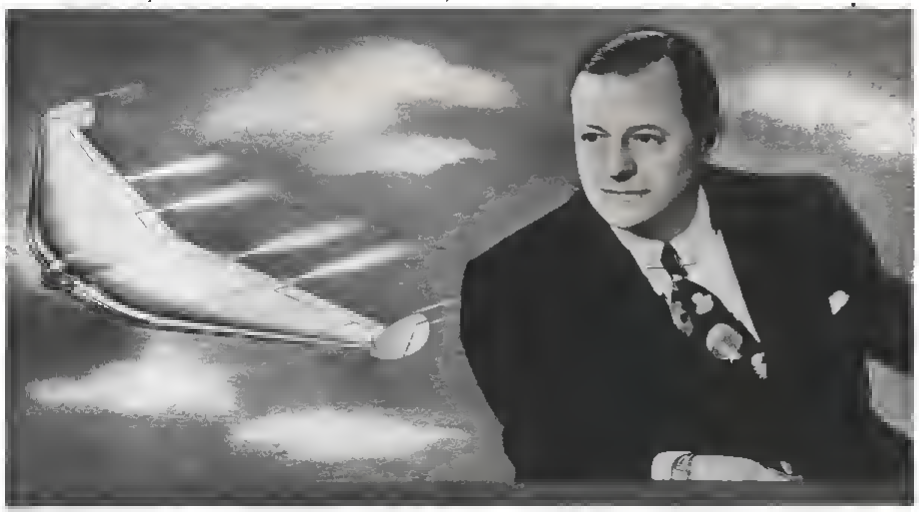
MACHINE TOOLS

DRILL PRESSES — HAND AND POWER FEED • RADIAL DRILLS
METAL-CUTTING BAND SAWS • POLISHING LATHES • FLEXIBLE SHAFT MACHINES
RADIAL CUT-OFF MACHINES FOR METAL • MOTORS • BELT & DISC SURFACERS

This is the twenty-fourth of a series of statements by aviation's leaders on THE SHAPE OF FLYING TO COME



"Jet Propulsion reaches into Tomorrow!"

by ROBERT E. GROSS, President, Lockheed Aircraft Corporation

TODAY, in America's advanced new types of fighter plane the industry has been able to combine successfully the jet principle with advanced aerodynamic design.

"The result is an exceptionally effective weapon of war. While its use will help the war, the true significance of jet-propelled warplanes reaches beyond that.

"It reaches into the tomorrow of great cargo planes that will combine jet propulsion with other forms of power to achieve takeoffs with heavier pay loads, increase economy of operation with low fuel consumption at high altitudes.

"It reaches into the tomorrow of the private plane, simplifying or even eliminating complicated present-day construction and maintenance problems, facilitating mass production.

"And it reaches into the tomorrow of great jet-powered transports which with increased speed and comfort and reduced noise and vibration, will serve and bring together the free peoples of a peacetime world."

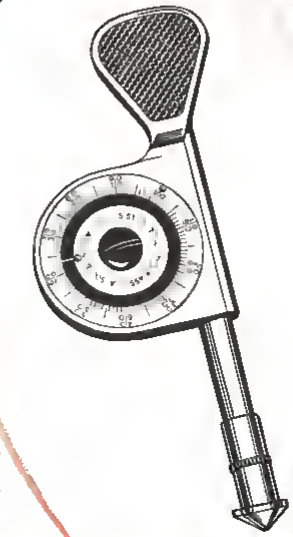
TOMORROW'S OBJECTIVE . . .

As the course is charted toward Japan, Southern works toward final Victory. The war in the Pacific demands full attention for the big push ahead. Some of the vitally necessary aircraft parts are being produced by Southern. Ahead is another objective . . . one in peacetime. When Japan capitulates, Southern Aircraft will reveal a program carefully thought out for peacetime flyers. When Victory is complete, Southern Aircraft's post-war products will support all America toward newer and higher goals.

ARMY NAVY

Southern
AIRCRAFT • CORPORATION
PLANT IN GARLAND DALLAS COUNTY, TEXAS

SPEED



ABRASIVE Rate of Speed is important for successful grinding at lowest cost. Work-carriage speed, work speed and wheel speed are all closely related to grinding wheel selection and economy.

In the Abrasive Company complete line of Grinding Wheels, thousands of combinations of abrasive types, grain sizes, grades, structures and bond types, meet all essential requirements, with due consideration to correct ratio of work speed to wheel speed.

Every Borolon (aluminum oxide) and Electrolon (silicon carbide) Grinding Wheel is manufactured under strict laboratory control, checked by scientific tests and rigid inspections. The identifying blotter on every wheel is your assurance of the accuracy of specification and top grinding performance when wheels are properly selected.

Abrasive Company Distributors stock or can make available a wide variety of Borolon and Electrolon Grinding Wheels, Segments; Mounted Wheels and Points; Grains, Bricks and Sticks. If you do not have the Abrasive Company 120 Page Grinding Wheel Data Book, a copy will be mailed on request.

Borolon and Electrolon Grinding Wheels are tested according to the Safety Code of the American Standards Association. Wheels are tested on special machines at speeds greater than their maximum operating speeds. Test and Maximum operating speeds are marked on wheels

abrasive Company
Division of Simonds Saw and Steel Company

ABRASIVE COMPANY, PHILADELPHIA 37 • DISTRIBUTORS IN ALL PRINCIPAL CITIES

PROVE For Yourself How NUGGETS Will Save You Money!

Yes... Costly, Inconvenient DUPLICATION is Necessary with Present Wrenches... but will be ABOLISHED BY NUGGETS

CHECK up on your present wrench equipment! You'll be *amazed* at the duplication! And, in a flash, you'll see the advantage of NUGGET Socket Wrenches. NUGGETS offer the FULL RANGE of sockets and handles in ONE DRIVE *for all work which otherwise requires wrenches in TWO DRIVES!* All need for ⅜" and ½" wrenches is abolished. NUGGETS, in ONE DOUBLE-DUTY DRIVE, reduce your original investment, slash replacement costs and help you do better work!

NUGGETS will be made again, when wartime limitations are lifted on the super grade steel required for this wrench miracle. So don't buy old-fashioned wrenches unless you absolutely need them. NUGGETS are worth waiting for.

TO PRESENT NUGGET OWNERS — If you have lost any of your NUGGET Wrenches, see your Blackhawk Jobber. He will arrange delivery of the replacements. Blackhawk wishes to protect the investment of present owners, even though NUGGETS cannot be made and sold on a mass scale to new buyers until after the war.

A Product of **BLACKHAWK MFG. CO., Dept. W2175, Milwaukee 1, Wisconsin**

Inventory of ⅜" Drive	Inventory of ½" Drive	TYPE OF WRENCH
		Ratchet
		Short Hinged Offset
		Long Hinged Offset
		Short Extension
		Medium Extension
		Long Extension
		Sliding T
		Brace
		Grip Handle
		Handle Bar
		Universal Joint
		Drag Link Socket
		HEXAGON SOCKETS
		5/16" Hexagon Socket
		11/32" Hexagon Socket
		⅜" Hexagon Socket
		7/16" Hexagon Socket
		½" Hexagon Socket
		9/16" Hexagon Socket
		19/32" Hexagon Socket
		⅝" Hexagon Socket
		21/32" Hexagon Socket
		11/16" Hexagon Socket
		¾" Hexagon Socket
		13/16" Hexagon Socket
		⅞" Hexagon Socket
		15/16" Hexagon Socket
		1" Hexagon Socket
		1-1/16" Hexagon Socket
		1⅛" Hexagon Socket
		1¼" Hexagon Socket
		DOUBLE SQUARE SOCKETS
		⅜" Double Square Socket
		7/16" Double Square Socket
		½" Double Square Socket
		9/16" Double Square Socket
		⅝" Double Square Socket
		¾" Double Square Socket
		LONG HEX SOCKETS
		7/16" Long Hex Socket
		½" Long Hex Socket
		9/16" Long Hex Socket
		⅝" Long Hex Socket
		11/16" Long Hex Socket
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		13/16" Long Hex Socket
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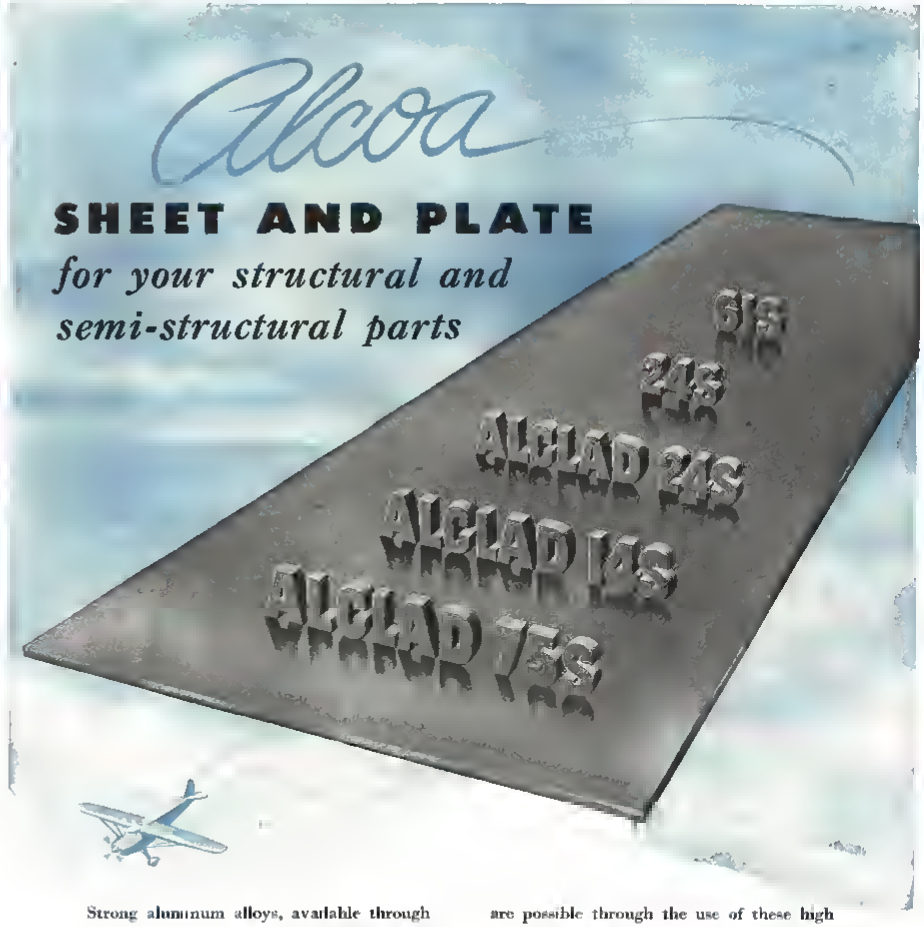
		15/16" Long Hex Socket
		1" Long Hex Socket
		1⅛" Long Hex Socket
		HEX UNIV JOINT SOCKETS
		⅜" Hex Univ Joint Socket
		7/16" Hex Univ Joint Socket
		½" Hex Univ Joint Socket
		9/16" Hex Univ Joint Socket
		⅝" Hex Univ Joint Socket
		11/16" Hex Univ Joint Socket
		¾" Hex Univ Joint Socket

BLACKHAWK NUGGET SOCKET WRENCHES

THE WRENCHES THAT SMASHED TRADITION

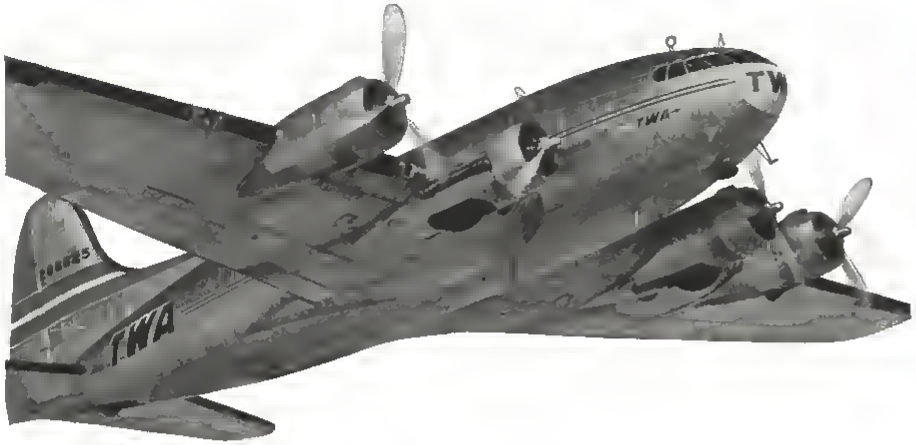


Strong aluminum alloys, available through Alcoa, now cover a wide range of mechanical properties. New design possibilities are being discovered by aircraft engineers as they employ these Alcoa Aluminum Alloys.

Lower weight—increased speed—reduced consumption—greater payloads—all these are possible through the use of these high strength aluminum alloys.

Information on forming, fabricating and heat treating these materials is available from Alcoa's engineers. Call our nearest office or write ALUMINUM COMPANY OF AMERICA, 2182 Gulf Bldg., Pittsburgh 19, Pa.

ALCOA FIRST IN ALUMINUM



Big Indians Back from the Warpath

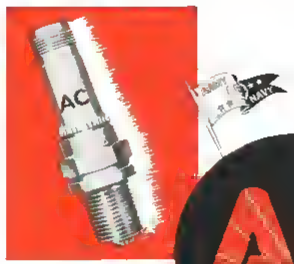
SPANNING the continent is again routine for the big four-engine Boeings, *Navajo, Apache, Zuni, Comanche* and *Cherokee*. After thirty months of global war service under the Army Air Transport Command, the immense Stratoliners were returned to TWA, reconverted, improved — and resumed cross-country schedules in April.

The four new 1200 horsepower Wright engines of each plane are equipped with AC Ceramic Aircraft Spark Plugs — symbols of *utmost reliability* since World War I — and used by TWA and several other leading American airlines.

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION

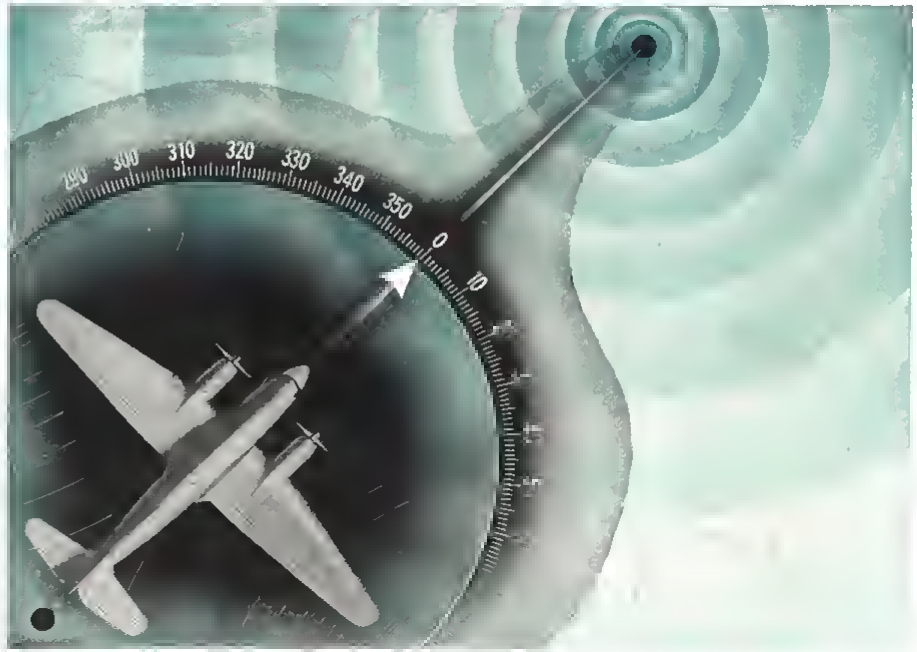
SPECIAL FEATURES OF TWA RECONVERTED STRATOLINERS

- Wing span — 107 feet 3 inches
- Length — 74 feet 4 inches
- Cargo capacity — 7890 pounds
- Two passenger cabins, main cabin seats 28, forward cabin, 10
- New "warm wall" air conditioning system operating both on the ground and in flight
- B-29 Superfortress type electrical system
- Electric kitchen



AC SPARK PLUGS

SPEED FINAL VICTORY — BUY WAR BONDS



Fly the Pointer

IT'S as simple as that! With the Sperry Automatic Radio Direction Finder, the pilot can quickly obtain the bearing of a radio station, check the drift, and *fly the pointer* home.

The Sperry Automatic Radio Direction Finder gives the pilot *continuous* and *automatic* non-ambiguous bearing indications, and simultaneous headphone reception. Even under conditions of severe rain, dust, or snow, static-free reception is maintained through the use of *shielded* crossed loops.

The non-hunting pointer indicates the correct bearing regardless of the maneuvers of the airplane or the effects of turbulent air . . . there is no overshooting of the pointer. This feature, together with a very high pointer speed, is extremely desirable for quick correction of drift when small changes in course are made.

Bearings may be taken on very weak signals . . . under favorable conditions reception is effective up to 1500 miles.

The Sperry Automatic Radio Direction Finder includes a self-contained power supply . . . 12 or 24-volt operation is available by throwing one switch on the receiver. Remote bearing indicators may be used, if desired.

Write our Aeronautical Department for further information.

The Sperry Automatic Radio Direction Finder is used by TWA, Braniff, Colonial, Northeast, Alaska, and American Airlines.

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

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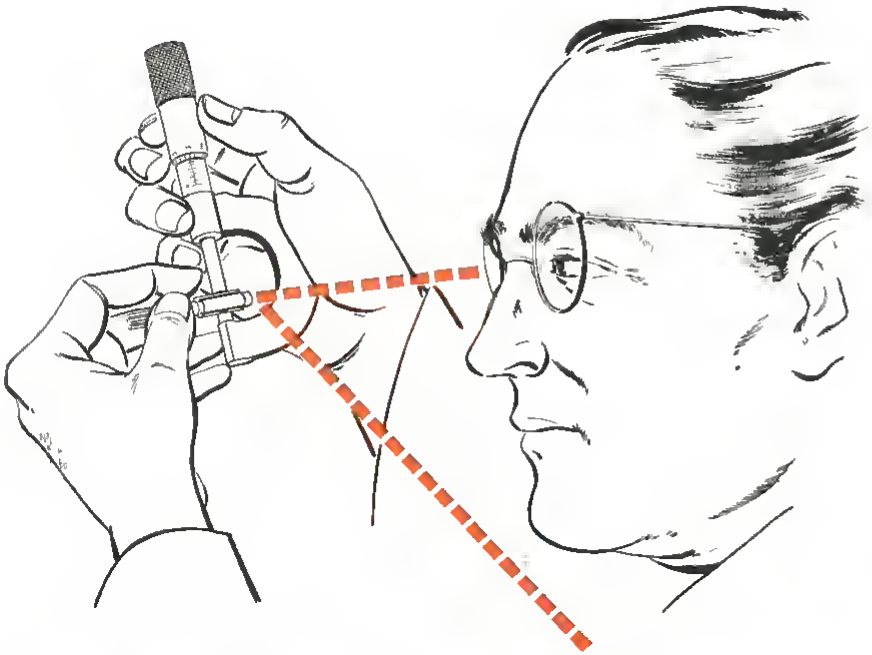


FINER PRECISION ASSURES GREATER RELIABILITY

● If the pumping of gasoline, water-alcohol or other fluids is important to you, then do not underestimate the value of high precision engineering in the pumps you select for your long range peacetime program.

The wide and varied experience of Romec in solving numerous pump problems for many years will enable us to serve your peacetime needs even better than before the war.

We salute the Navy and the Air Forces for having given us the opportunity to do an engineering and production job that exceeded expectations.

ROMEC PUMP COMPANY • 117 ABBE ROAD, ELYRIA, OHIO

Romec

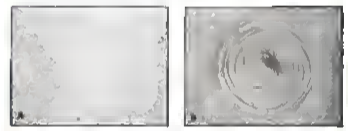
"Quilting" of fabric covered surfaces at 400 M.P.H. plus puts extra strain on doped fabric ... demands a finish that won't crack under deflection even in the stratospheric cold.

Here's the perfect set-up for EMYCEL. Sub-zero temperatures don't faze this all-climate fabric finish. Its super-flexibility is just as efficient in the stratosphere as in the humid heat of the tropics.

Super-flexibility at low temperatures is just one of the unique advantages of EMYCEL. This Roxalin engineered system can be applied in any weather without blushing. Four or five coats do the work of eight to twelve of conventional material . . . cuts down fabric finishing time as much as 30%. Roxalin's patented fungicidal principle protects fabric against mildew and dry rot.

EMYCEL is C. A. A. approved and backed by more than four years of world-wide service on all types of aircraft. Write to Department 805 for complete technical portfolio.

HOW EMYCEL MAINTAINS LOW-TEMPERATURE FLEXIBILITY



Airplane fabric Panel A was finished with four coats of Emycel. After ageing approximately one month it was placed in a low temperature box and temperature reduced to 65°. Then a ½ lb. steel ball was dropped from inside the box at a height of two feet. The Emycel finished surface was unaffected by the impact.

Panel B was finished with a conventional system using six coats of dope and given the same treatment as the Emycel finished panel. The shattering caused by the impact of the ½ lb. steel ball is plainly visible.

ROXALIN Flexible FINISHES
INCORPORATED
ELIZABETH, N. J. ● NEW JERSEY

WATCH ROXALIN IN AVIATION

WHY AIRPLANES OF THE FUTURE WILL HAVE THERMAL ANTI-ICING

Actual Unretouched Photographs—Courtesy of National Advisory Committee for Aeronautics

Another Product of STEWART WARNER

South Wind

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West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service

1273 Westwood Boulevard, West Los Angeles, California

Heating

NEATER DIVISION, STEWART-WARNER CORPORATION, CHICAGO 14, ILL.

Actual Unretouched Photographs—Courtesy of National Advisory Committee for Aeronautics

TODAY, thermal anti-icing is on the job in our huge cargo ships and bombers. It is proving itself to be the answer to icing conditions in the toughest kind of weather. It is saving lives and enabling missions to be flown that otherwise would be an impossibility. On today's performance alone, greater safety from icing is definitely assured—now and for the future.

The reasons for the superiority of thermal anti-icing are simple. It can provide *complete* protection *against* the formation of ice on wings. It can be made so *simple* that its operation does not require any special skill on the part of the pilot. The use of heat sources with the reliability and long life of those made by South Wind can make thermal anti-icing systems practically *free from service* or maintenance problems.

For instance—to date, 9000 South Wind heat exchangers have been installed on combat aircraft. Many of these exchangers have been in continuous service for approximately a year. *There has not been one report of exhaust gas leakage—except through battle damage.*

405 Emerson-Electric Aircraft motors developed from 5 basic frames

All in this book...

405 AIRCRAFT MOTORS

WITH this Emerson-Electric Aircraft Motor Data Book you can greatly simplify your design problems. It contains more than 3,200 pertinent specification details on 405 Aircraft Motors, with ratings from 1/200th to 6 h. p. —Full-load standard speeds from 1750 to 7500 r. p. m.— Weights from 17 ozs. to 23 lbs.—Full-load amperes from 0.9 to 290—Reversible or unidirectional rotation—PLUS numerous modifications of speeds, mountings, drives, and couplings.

To help you with any special Aircraft Motor application problem, a competent sales engineer from your nearest Emerson-Electric sales office is available for consultation.

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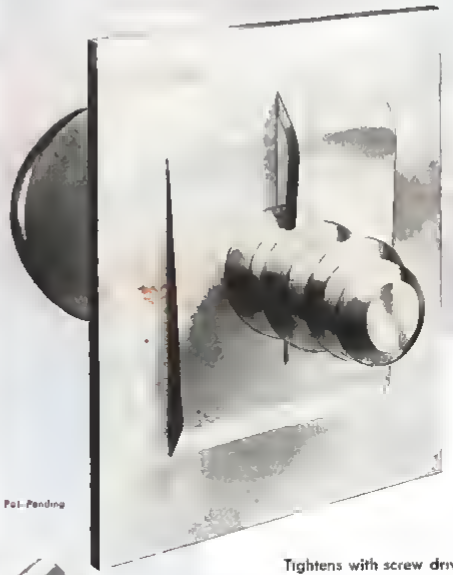
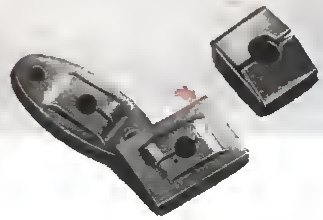
MOTORS · FANS — APPLIANCES

Meets and Exceeds AAF SPECIFICATIONS



Pat. Pending

TNAT'S *STALOCK, "THE ALL AROUND FASTENER." IT MEETS AND EXCEEDS SPECIFICATIONS (AAF 25533) AND NAS BEEN AWARDED AAF RATING!



OK for war—preferred for peace! This one piece, self-locking, resilient, sheet metal fastener *stays locked.* Finds its own way on screw threads. Tightens with screw driver without need of wrench. Eliminates lock washers and bearing washers. Grips "all around" with 360° thread engagement. Under extreme tension tests, screw threads strip before nut fails. Re-usable, saves weight, cuts costs, speeds assembly. No sharp edges nor vulnerable "fingers." Saddle, anchor, flat types and a wide variety of other types and sizes available. May also be formed as integral part of your assembly. Write for specifications, technical data and catalog. Address Dept. N-1502

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Burbank, Calif. / Huntington, W. Va.
Offices: Seattle 1, Wash.; Dayton 2 Ohio; Detroit 2 Mich.; Hagerstown, Md.; Baltimore 1 Md.; New York 20, N.Y.
In Canada: Railway & Power Engineering Corp., Ltd.

ADEL
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LOOK TO ADEL FOR PRODUCTS OF *Design Simplicity* AND *Dependability*

Saginaw BALL-BEARING SCREW AND NUT

Friction-Free!

The Saginaw Recirculating Ball-Bearing Screw and Nut offers revolutionary friction-free operation, introducing new efficiency to unlimited applications. Moving smoothly on rolling balls inserted between the threads of the nut and the screw, it boosts actuating efficiency to 90 per cent and up, for the first time in the science of screw mechanics.

Aircraft designers have been quick to recognize the importance of the Saginaw Ball-Bearing Screw and Nut in their field. It can be used to actuate wing flaps, surface controls and trim tabs; to raise or lower landing gear; to open and close loading doors or bomb bay doors; to turn turret mechanisms; to operate wing-folding devices, and for varied other uses. Wherever there is a problem of elevating or lowering, opening or closing, expanding or contracting, the Saginaw Ball-Bearing Screw and Nut brings new friction-free efficiency.

Freedom from friction permits greater speeds with less heat generation . . . reduces horsepower and weight requirements of the driving mechanism . . . insures smooth, positive action. Our engineering department will be pleased to work with you in designing the right unit to meet your requirements.

Write for free descriptive booklet on your company letterhead. Department 25-AV-7, Saginaw Steering Gear Division, Saginaw, Michigan.

THE PRINCIPLE—Unlike the ordinary nut and bolt, the Saginaw Ball-Bearing Screw and Nut has rolling balls inserted between the threads of the nut and bolt, thus easing friction and decreasing actuating effort. The balls recirculate through a special raceway (see inset). Operating effort is decreased two-thirds, efficiency is above 90 per cent.

KEEP BUYING WAR BONDS

Saginaw Steering Gear
DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN.

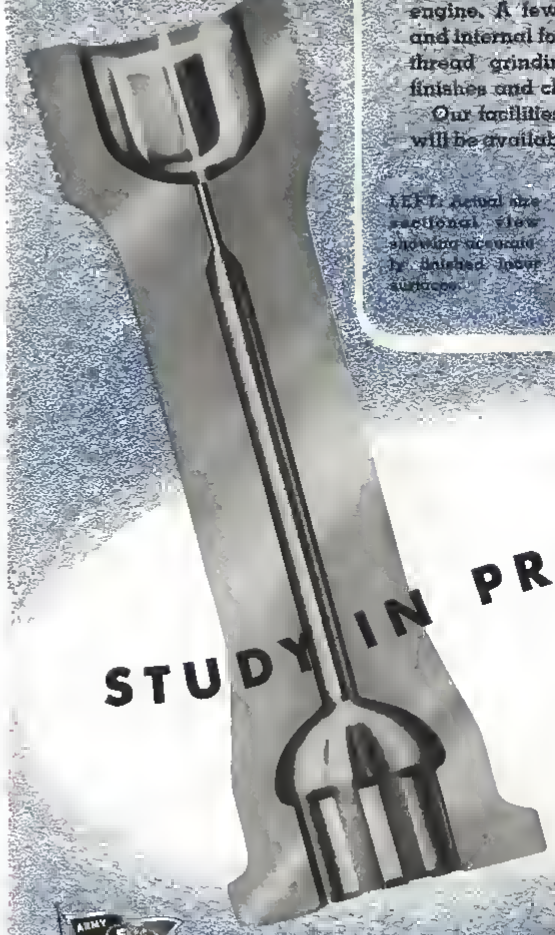
MANUFACTURER OF STEERING GEAR ASSEMBLIES, STEERING LINKAGE ASSEMBLIES, UNIVERSAL JOINTS AND PROPELLER SHAFTS, DIESEL ENGINE AND AIRCRAFT PARTS.

PRECISION Lawson

58 operations are necessary to produce this unusual bolt for an aircraft engine. A few of these being external and internal form grinding, heat treating, thread grinding, splining, etc., to fine finishes and close tolerances.

Our facilities for similar workmanship will be available for your post war needs.

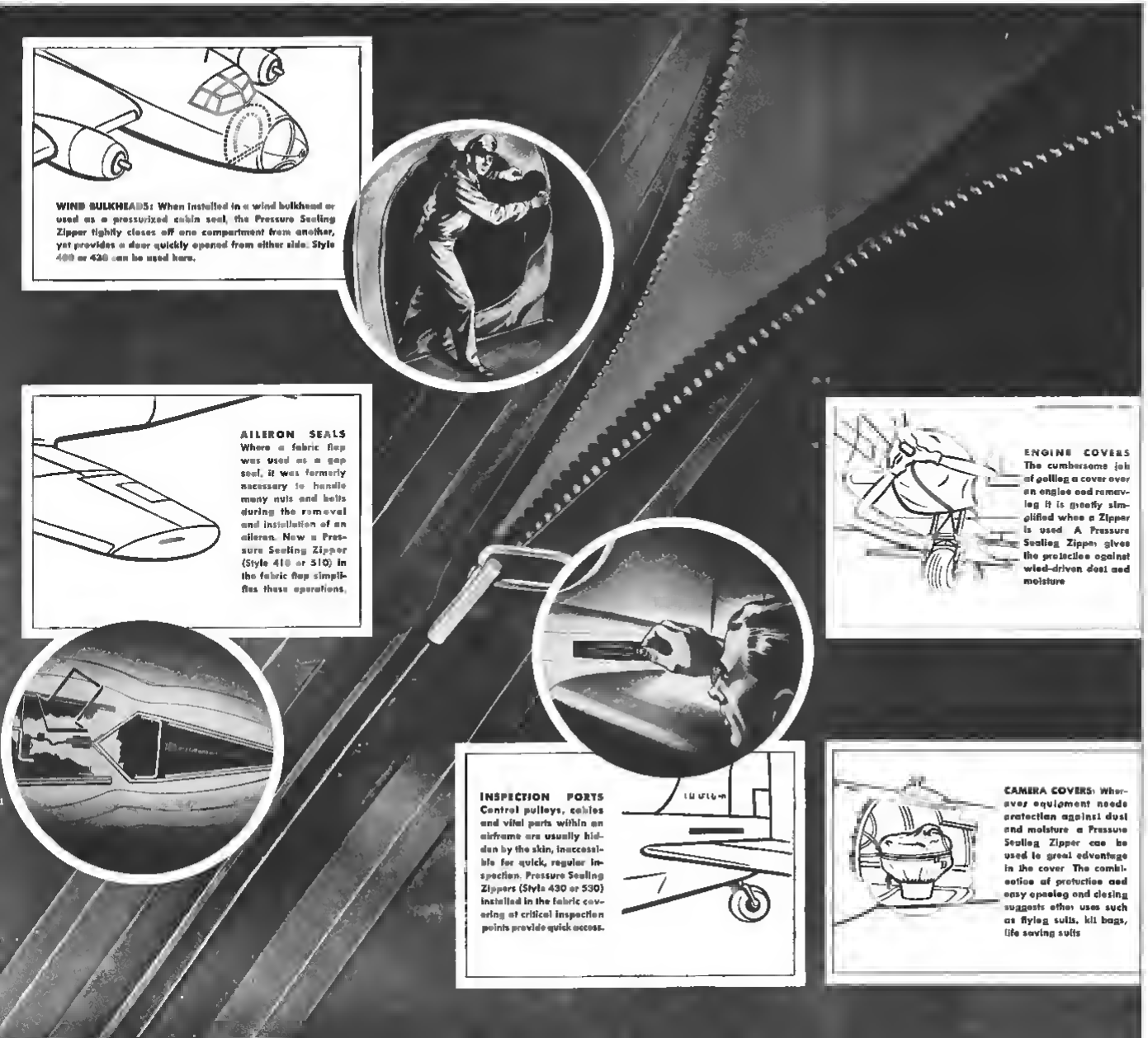
LEFT: Actual size sectional view showing accurately finished bore surfaces.



STUDY IN PRECISION

LAWSON MACHINE and TOOL CO.
120 MOUNTAIN AVENUE, MALDEN 48, MASSACHUSETTS

Wide range of applications fornew Pressure Sealing Zippers



WIND BULKHEADS: When installed in a wind bulkhead or used as a pressurized cabin seal, the Pressure Sealing Zipper tightly closes off one compartment from another, yet provides a door quickly opened from either side. Style 400 or 430 can be used here.

AILERON SEALS Where a fabric flap was used as a gap seal, it was formerly necessary to handle many nuts and bolts during the removal and installation of an aileron. Now a Pressure Sealing Zipper (Style 410 or 510) in the fabric flap simplifies these operations.

ENGINE COVERS The cumbersome job of pulling a cover over an engine and removing it is greatly simplified when a Zipper is used. A Pressure Sealing Zipper gives the protection against wind-driven dust and moisture

INSPECTION PORTS Control pulleys, cables and vital parts within an airframe are usually hidden by the skin, inaccessible for quick, regular inspection. Pressure Sealing Zippers (Style 430 or 530) installed in the fabric covering at critical inspection points provide quick access.

CAMERA COVERS: Wherever equipment needs protection against dust and moisture a Pressure Sealing Zipper can be used to great advantage in the cover. The combination of protection and easy opening and closing suggests other uses such as flying suits, kit bags, life saving suits

Perhaps *you* can use this quick opening and closing air- and water-tight seal

EVEN under high pressure, liquids and gases can't leak through a new kind of Zipper recently introduced by B. F. Goodrich. Its positive sealing action, coupled with the advantages of quick opening and closing, has opened the way to many interesting applications, some of which are illustrated.

Below is a cross-sectional diagram showing how this positive sealing action is achieved. B. F. Goodrich engineers have taken a slide fastener and added a precision-molded rubber seal that opens and closes with the fastener. It is a unique arrangement of overlapping rubber lips which provides an effective and complete seal from zero pressures to pressures up to the structural strength of the fastener itself.

Pressure Sealing Zippers can be applied to metal, fabric, or sheet rubber, provided a sufficient clearance is allowed for proper operation of the fastener. They may be installed by stitching or cementing, depending on application.

These Zippers are effective in a wide temperature range. The rubber won't crack when bent at -70° F nor become soft at 150° F. Weatherability is good; aging tests have shown present compound is best for this type of product

4 Styles Available

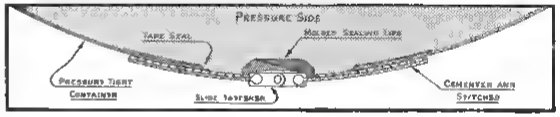
STYLE 400: *Non-separating type. Seals throughout its entire length but is open at the top. Slider operates from either or both sides*

STYLE 410: *Separating type. Seals for entire length but not at end. Slider operates from either or both sides.*

STYLE 420: *Non-separating type. Seals at both ends and along entire length. Slider operates from side opposite sealing lips*

STYLE 430: *Non-separating type. Seals at both ends and along entire length. Slider operates from either or both sides.*

The above styles use Talon fasteners size 1-A. A smaller size on a Talon 5-6 is available in styles 500, 510, 530 corresponding to the 400, 410 and 430 described above. The B. F. Goodrich Company, Aeronautical Division, Akron, Dept. A-7, Ohio.



All made by B. F. Goodrich

. . . Tires for light planes, transports, combat . . . Expander Tubes for brakes . . De-icers . . . Feed Shoes and Electrically Heated Shoes for propellers . . . Fuel Cells . . . Gaskets . . Hose . . . Rivets.

Skyway or Highway

B.F.Goodrich

FIRST IN RUBBER

STEADY JOBS *and* EQUIPMENT BUYING

SUSTAINED employment is not an attainable goal unless we can moderate the erratic fluctuations which have characterized the markets for producers' equipment in past periods.

In the 35th editorial of this series, "Sustained Construction Activity", it was pointed out that there is no specific that can cure our economy of its "boom-or-bust" proclivities. Rejecting the notion that the construction industry could be so managed as to stabilize business as a whole, that editorial stressed the important contribution it could make to that end, and suggested several practical expedients through which construction activity might be regularized.

Producers' equipment represents an area of production quite as broad and diverse as construction, though smaller in aggregate value. The classification embraces all types of durable equipment bought and used for profit—locomotives, motor trucks, electric generators, conveyors, machine tools, farm implements, and so on down to surgical instruments and dentists' drills.

Although the output of such equipment averages over a long period only 5 or 6 per cent of the nation's total output, it resembles construction in its extraordinary ups and downs. While its component items differ widely in the amplitude and violence of their fluctuations, the class as a whole is one of the most unstable sectors of the economy, making therefore a quite disproportionate contribution to the cyclical swings of total production and employment. From 1929 to 1932, for example, the decline in the output of producers' equipment (at constant prices) was 65-70 per cent, in contrast to a decline of 25-30 per cent in the national output exclusive of such equipment and construction.

A more recent example of the volatility of demand in this field may be found in the movement of a monthly index of orders for industrial equipment, which rose from 92 in the spring of 1936 to 160 in the spring of 1937, falling thence to 65 in the summer of 1938 and rising again to 142 in the fall of 1939. Such fantastic oscillations present an obvious and inescapable challenge to all concerned with economic stabilization.

Not only are these fluctuations bad for the economy; they represent demonstrably bad buying policy on the part of the purchasers of equipment. Peaks in demand come characteristically just before a business depression (1919, 1929, and 1937, for example) when machinery costs the most to buy and install and when it has the lowest expectancy of continuous use. At exactly the wrong moment everyone wants to buy. In the depression itself, on the other hand, with costs down, and with nowhere for the economy to go but up, equipment is a drug on the market. No one wants it when it is cheap and has the greatest prospect for steady employment. Here is a behavior pattern so profoundly irrational there must be hope for its correction.

There is an inveterate tendency for business management to forecast the future simply by projecting the trends of immediate past. Although it is axiomatic that the chance for an extended period of further prosperity is inversely related to the duration of the prosperity already experienced, this truism is generally ignored. The longer the boom has run, the more certain is business management that it will continue indefinitely. Convinced at last by "actual experience" that prosperity is here to stay, executives give the green light to commitments for expansion and modernization previously deferred in a skeptical attitude of "wait and see". The result, so often repeated in our economic history, is an explosive burst of demand for equipment coincident with, and contributing to, the final spasm of a boom. Witness the phenomenal rise in industrial equipment orders during 1928 and the spring of 1929.

The same prophetic illusion works in reverse during a depression. Recent experience is projected into the future. Although the mathematical probability of an imminent and prolonged period of prosperity increases directly with the duration of a depression, it finds little reflection in business decisions. Timidity and caution are the order of the day.

Compounding the errors caused by faulty perspective, are a number of influences which make it extremely difficult for individual enterprises to follow a policy geared to sensible long-term considerations. In a boom, particularly in its climactic phase, most producers find their order books crowded beyond the potential of their current capacities and are faced with the alternatives of expanding or losing trade to competitors. In depression the situation is reversed, and producers with unused facilities find it difficult to justify increases in their capital charges.

An even more controlling factor in many cases is the availability of funds. This is especially important

for small concerns. Typically such firms enjoy but limited credit, and with no ready access to the securities markets, their capital expenditures depend primarily on earnings. When they are making money, they can afford to buy equipment; when they are losing, they largely disappear from the equipment market. Even great enterprises, though less dependent on earnings as a source of capital financing, are profoundly influenced by the volume of internal funds available for the purpose, a volume as a rule far greater in prosperity than in depression. Moreover, it is usually easier in good times to obtain outside funds through the sale of stock or by borrowing, since in bad times bankers, underwriters, and investors are susceptible to the same timidity and caution that afflict business management generally.

We are dealing here with a combination of psychological, physical, and financial forces which conspire to aggravate the instability of demand for capital equipment. What can be done to reduce this instability and thus to bring equipment purchasing into a more sensible and constructive pattern?

There is no panacea, no royal road to the solution. The problem has been with us since the beginning of the industrial economy. It is complex and difficult. It is not, however, wholly intractable. We may reasonably hope that industry will, through intelligent effort, make substantial progress toward a satisfactory solution. The industrial equipment field is one in which government, except for war periods, has exerted little direct control. The best insurance against the institution of government measures is to so conduct activities in the equipment field that no justification for government interposition can be made.

☆ ☆ ☆

1. The first and most important step is for industry itself to reconsider its heretofore haphazard and opportunistic policy in the purchase of equipment, substituting so far as possible a regularized, long-range programming of expenditure that will resist both the excited long-buying of booms and the equally disturbing underbuying of depressions. Such long-range programming is particularly appropriate and advantageous for large enterprises in established industries such as railroads, electric power, steel, automobiles, and the like, but it makes sense much more generally.

Once executives come to realize that a reasonably stable equipment program contributes not only to the welfare of the economy but also to the lowering of their long-run equipment costs, the opportunity to combine a public service with private advantage should induce them to recast their policies accordingly.

There is an even more compelling reason for purchasers of industrial equipment to do everything possible to regularize their demands. Some concerns unquestionably will find themselves in a postwar position where speedy delivery of needed equipment, even though it involves the payment of premium prices, will seem to be justified. But there is no system of accounting that can show it to be a profitable transaction to promote an equipment industry boom that runs a brief course only to collapse when the backlog of deferred maintenance and development has been satisfied. That, historically, has been the trigger which trips the door to the depression phase of the business cycle. No immediate advantage can compensate for the contagious paralysis that infects all business enterprise when major layoffs occur in any major segment. No precautionary measures, self-imposed by business, can be regarded as unduly severe if they can prevent this devastating blight.

2. Financial agencies can and should play a responsible role in regularizing equipment demand. Funds for the purchase of producers' equipment should be offered boldly and at low interest during depression periods, and should progressively tighten as a boom market bids up the price of purchase and installation. Banks and financial houses have excellent facilities for gathering and interpreting market and general economic information. It is good business for them, and for the national economy, to exercise their accepted discretions in a manner that will help to promote economic stability.

3. There now is almost universal recognition of the need for a thorough-going revision of our corporate tax structure to the end that effective incentives may be offered for private capital investment. The possibility of including provisions which would offer special tax concessions to equipment investments made in depression periods is worthy of intensive exploration.

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The fundamental problem here is educational. If all business enterprises in a position to do so were to regularize their equipment expenditures, it would have a tremendously beneficial effect. True, it would accomplish no miracles. For many concerns it is not feasible to schedule equipment buying over a long period. Even those who do schedule it are likely in practice to attain only a relative stability. It must be acknowledged, moreover, that few programs could withstand indefinitely a very deep and prolonged depression such as we had in the thirties. Nevertheless the adoption of stabilization policies where feasible would make a signal contribution both to the restraint of booms and to the mitigation of depressions. Here is something industry can do for itself.

It is easy to disparage such remedies for economic instability as are here proposed on the ground that they are partial only. However, joined with others also partial, they can achieve in combination a solid progress toward the goal of sustained high level employment—progress that is unattainable through economic cure-alls. The road suggested is a slow road, and difficult, but it leads upward.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

THIS IS THE 37TH OF A SERIES

EDITORIAL

Cutbacks Must Be Handled With Care

WITH MILITARY VICTORY in Europe less than two months old there are disquieting signs of divergent views among the victors and many unsolved political problems in many places in the world. Those who expected a miracle to rise up out of the mist of San Francisco Bay are destined for disappointment. Those who are more realistic in their appraisal of world peace efforts know that there are years of disheartening work ahead before the complete structure of a security organization can be built and made to function.

In spite of all these cold facts a substantial segment of the American people has written off the war and settled down to personal postwar planning. Even in Congress legislation important to our future security has been sidetracked or is being shelved at a time when we as a nation are becoming much less warlike each succeeding day.

We are still awaiting the initial steps in the formulation of basic long term airpower policies. And our capacity to build aircraft has already begun to be cut back.

WE CANNOT EXPECT to maintain our aviation industry at wartime levels indefinitely, but we must not be too eager to cut it back. There is less to be feared from orderly deflation than there is from the possibility of unwillingness of the American people to maintain our dominant airpower. As long as the industry is not permitted to shrink below the point where it can develop a continuous procession of new and better designs, as long as it preserves a sound nucleus capable of quick emergency expansion we need have no fears for the future.

But a minimum point must be determined and no degree of complacency must be permitted to influence us to go below it. In no other major nation in the world is aviation technology being permitted to lag, and we dare not arrest scientific progress by impairing our efforts in that direction.

IN HIS BRILLIANT Wilbur Wright Memorial Lecture, excerpted on page 106, Civil Aeronautics Administrator T. P. Wright has made some predictions, in terms of employment, of the size to which the whole aviation industry may be expected to shrink 8–12 years after the war. If these estimates are possessed of the same uncanny accuracy as those he made for the expansion of the manufacturing industry, we may rely on them as completely as did hundreds of manufacturers planning their expansion.

Mr. Wright envisions a total personnel level of more than 600,000, including manufacturing, operations and government agencies. This estimated figure represents a substantial shrinkage from the war time peak but is about twelve times the prewar level. Of this total some 335,000 employees are expected to constitute the personnel of the manufacturing industry, but only 210,000 will be engaged in military aircraft manufacturing. Whether this number will provide an industry sufficiently large for our national security is a question deserving urgent consideration.

Mr. Wright probably bases his estimates on the assumption that in 8–12 years we will have reached a period in which the nations of the world have learned to settle their disputes by diplomatic means. This is a condition for which all of us most fervently hope. But it is the interim period which we are just about to enter that will be the critical time in world history.

The prospects that the United States can influence the world toward peaceful ways will be much brighter while we possess the world's largest air force and the productive capacity to keep it in the dominant position. If we permit our airpower to weaken—and with it our technological leadership—the hope for world peace will fade with great rapidity.

Jerry E. Burke

EDITOR

AVIATION'S PLACE IN CIVILIZATION

Properly used, the airplane can be a tremendous force for world peace, as is shown by forecasts of air transport and personal flying developments . . . Excerpts from the 33rd Wilbur Wright Memorial Lecture presented before the Royal Aeronautical Society by—

By T. P. WRIGHT, *Civil Aeronautics Administrator*

LET US FIRST DEFINE the terms of our subject. Aviation, of course, is the art of flying. Civilization is a condition of human communities, characterized by political and social organization and order; advancement in knowledge, refinement and the arts, and continuous progress in the realization of social, cultural and religious values. The problem which we must see and really appreciate exists is, therefore, can we so manage aviation that it will contribute to the development of civilization?

In World War II air power has taken a position of equal importance with other services. In some respects the importance is greater, although any attempt to appraise relative roles of the air, land and sea arms is misleading, as it has been proved time and time again that their coordinated use is in most instances essential.

We must stress the tendency of modern war towards total destruction—a truly vicious spiral insofar as progress of civilization is concerned, and again we must appraise our ability to master ourselves in using the types of weapons which we now have available. Locating our factories underground and possibly moving many more activities similarly can only be looked upon as a retrogression and probably an ineffective measure. In this regard, although dealt with later more extensively, I would like to introduce here the conception of the tremendous difference between war and policing, the one for destruction to attain national ends, the other to maintain order and achieve security for all.

It is appropriate to stress the fact that warfare has changed from a conflict between the armed forces to total war which encompasses whole populations both as targets and as producers of weapons. Possibly this can be best illustrated by indicating the extent of our aircraft production program in the United States. For this purpose, there are shown two curves, Fig. 1 indicating graphically the output from July, 1940, to the present time in terms of airframe weight, airframe employees and resultant efficiency, as pounds per employee per month.

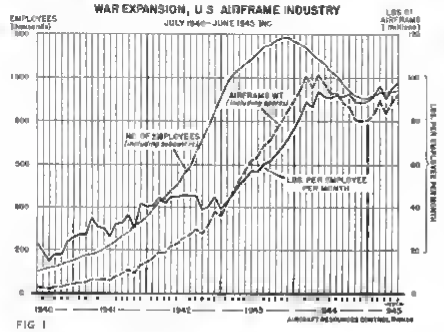


FIG. 1

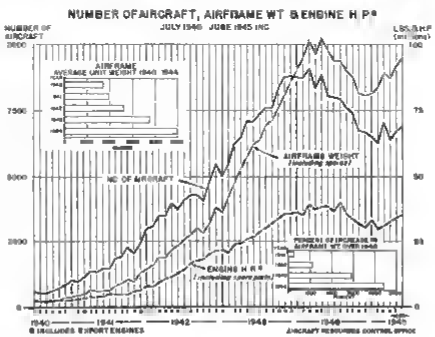


FIG. 2

United States Employment—Derived from Aviation
A Forecast—If 12 Years After the War

Manufacturing—(*1)		
Personal Aircraft	100,000	
Transport Aircraft	25,000	
Total		125,000
Military		210,000
Total Manufacturing		335,000
Air Transportation—(*2)		
Scheduled (Domestic)	115,000	
Scheduled (International)	30,000	
Nonscheduled	30,000	
Total		175,000
Service Industry		80,000
Government		20,000
Total Air Transportation		275,000
Grand Total—(*3)		610,000 (*4)

*1—Includes Grass Roots Employment at 33⅓% of Total
*2—Includes Grass Roots Employment at 20% of Total
*3—The Money Value of the Products and Services Given Are Just Under Three Billion Dollars
*4—Prewar Employment was 50,000. War-Time Peak Excluding Uniformed Personnel 3,750,000

Fig. 3

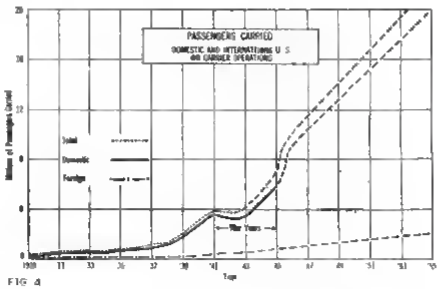


FIG. 4

On Fig. 2 is shown the climb in output during the same period repeating the airframe weight curve and adding the story on engine horsepower and number of airplanes. The magnitude of the effort is also depicted in terms of increase in airframe weight. Compared to July, 1940, production the war period shows a 4,500 percent increase. The 3-fold increase in the average size of aircraft during the period is of interest. In round numbers, the annual aircraft deliveries in the U. S. starting with 1940 were 5,000, 19,000, 48,000, 86,000, and finally in 1944, 96,000. But because of this increase in average size the yearly output in terms of airframe weight increased from 21 million lb. in 1940 to 1-1 billion in 1944—over 50-fold.

Let us appraise this increase and its present status in terms of overall national economy. Here we find that the manufacture of aircraft (completely applied to the waging of war) has, in the United States, attained a relation, when compared in total munitions output of 27 percent, to total manufacturing output of all kinds, of 20 percent, to total national income, of 10 percent. These facts, considered in conjunction with the deficiencies in manpower present in all countries and the very high percentage of female employees in war factories, stress the total character of modern warfare. Even in peace times upward trend of costs for military preparation could but be viewed with alarm. In the Axis states in the 1930's it approximated 25 percent of national income.

It should be noted that, with the exception of the specific military character of some of its cargoes, all uses developed during the war for the air transport plane will have direct application to peacetime functions.

At the present time very great effort is being made by the CAA to lay a proper foundation for a rapid but sound development of private flying, the importance of which can scarcely be overestimated. The encouragement to the owner of the personal aircraft furnished by CAA is incorporated in four-plank program.

First is the establishment of airports, particularly those of the smaller sizes adapted for use of the private flyer. At present the airports in the United States total about 3,000. The federal aid airport program which we have suggested to the Congress for consideration envisages an increase to 6,000. Over 80 percent of the increase will be in the smaller Class I and II airports. The program is so planned as to place airports at relatively uniform distances and in sufficient numbers in communities as to make private flying really practicable as is the case with the automobile driver who has surfaced roads available for his use.

The second point is to examine existing regulations and their effect on private flying, with view to making recommendations to the Board covering changes which will to the maximum extent possible commensurate with public safety relax requirements and make it easier to obtain a pilot certificate and otherwise enhance the attractiveness of personal aircraft ownership and operation.

The third point is the encouragement of aeronautical education and pilot training. It is hoped again to establish a federal aid pilot training program which, in company with the high school educational work that is being established, will make the coming generation universally minded

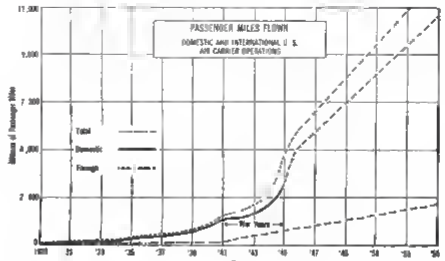


FIG. 5

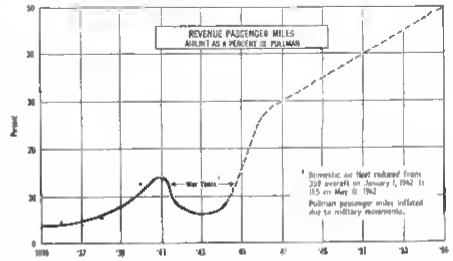


FIG. 6

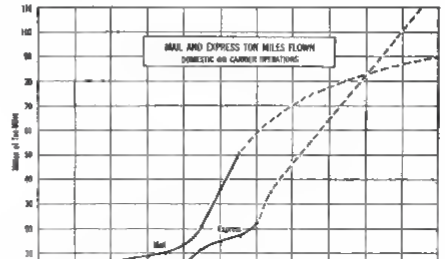


FIG. 7

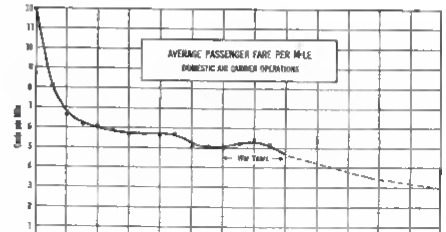


FIG. 8

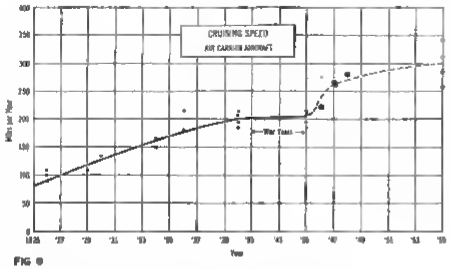


FIG. 9

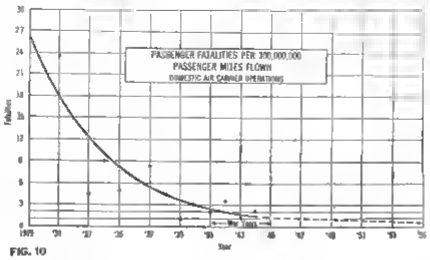


FIG. 10

The final plank in the program is the development of the personal aircraft itself, which, although it will be carried out in detail by the aircraft manufacturing industry, will be fostered and aided by the CAA. It is believed necessary in order to attain our present goal consisting of a registered total of 400,000 planes ten years hence, that the personal aircraft must be considerably improved in a number of respects. Its price must be reduced, its safety enhanced, its utility increased by means of improved performance, and several features added which will make it in general more attractive. Here I refer particularly to such improvements as the decrease in noise, making flying more pleasant not only for the occupants of the plane, but for the residents living adjacent to the airparks, which, under our airport program, must, we feel, be located within residential sections if they are to serve their proper purpose. Another feature in the development of the airplane itself is the further development of the undercarriage, possibly along the lines of the Maclaren gear developed in England, which will make crosswind landings safe and practicable.

It is the hope of those of us involved in carrying through this program that we may contribute towards meeting the overshadowing need of our generation for intelligently organizing government operation dedicated to the advancement of the common good—in this case, aviation. In this highly specialized age it is particularly necessary that government cooperation be extended in such fields as the average man cannot possibly keep abreast of the rapidity of technical advances.

Another point to note is the cooperative nature of development, contributions coming from many people in many nations. This was amply evident to me during my trips to England during the war, when a slightly different point of view which had gained ascendancy in your country led to long trains of fruitful speculation on developments which we were considering or had undertaken.

It is important that we use this vast reservoir of knowledge acquired during the war for advancing the general welfare thereafter. Through intensification of research and implementation of technical education, and with the groundwork in technical development in aviation which we now inherit, we are, I believe, on the threshold of the greatest period of aeronautical development that has yet been witnessed.

To mention but a few items which may revolutionize development I would cite: the gas turbine and jet power plant, which will increase in efficiency as aircraft speeds go up, thus making aerodynamic development a limiting factor in speeds to be attained as distinguished from the power plant limitations (including the propeller) already reached at speeds of 475 mph.; laminar flow wings; the development of structural designs suitable for such wing shapes, especially in thin sections, necessary to surmount our next barrier—compressibility.

Our greatest effort from the research standpoint in the next period of time will be the investigation of aerodynamic phenomena at supersonic speeds. Possibly we have far to go before transcending the speed of sound, but the rapidity of present development indicates that this may be accomplished in the not too distant future. It is of interest to note that, having passed the speed of sound, there is some reduction in drag coefficient.

Developments of comparable magnitude and of equal importance to aviation are to be found in the electronic field. Electronic devices which will make all-weather operations safe and practicable are already in the offing and further developments, probably using radar, will make air traffic control a matter of individual separation as on the roads rather than by ground instruction and control. Each pilot will do his own flying, so to speak, his own instrument weather navigating, determining from his instrument board "screen" his proximity to others.

Then there is the helicopter, (only just getting itself off the front pages of popular magazines), which will experience an intensive development which bids fair to make it a popular private plane of the future. It will supplement the air transport plane as the automobile does the railroad. There are, of course, possibilities of combinations of rotating and fixed-wing aircraft, which may achieve both low landing speed and high cruising speed, not apparently attainable by the helicopter itself.

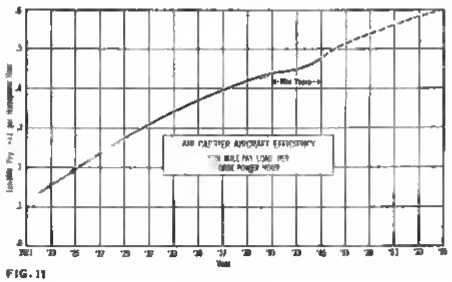


FIG. 11

Accompanying these technical developments is the need for simplifying operation of the aircraft and reducing costs, particularly in the private owner field so as to make possible the tremendous expansion there which many envisage.

Again I express it as my considered belief that

(*Turn to page* 260)

Concluding a most important series, this veteran industry leader shows that adequate air transportation, postwar employment, and national security factors all contribute to one urgent demand—

Let's Have Feeder Airlines Now

PART IV OF A SERIES

By **JAMES G. RAY,** *Vice-President, Southwest Airways Co.*

A FACTUAL APPROACH to the problems of feeder airline service has been the aim in our preceding three articles. Traffic projections for feeder towns, for example, were based on the actual traffic generated by towns of similar size and location having air service in 1940. The results of this method of study must be interpreted in relation to other basic considerations. A more philosophic approach is necessary to see the whole problem in its true light.

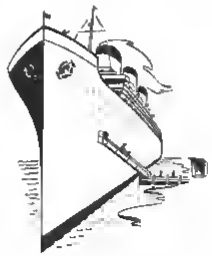
The sample towns did not have feeder airline service—they only were afforded the local air service that a trunk line can furnish as a by-product of its through service. And there is a great difference. The schedules were generally infrequent and the service at inconvenient hours. That a seat would be available was uncertain. Flights were often delayed, possibly by adverse flight conditions a half-continent away.

Such service is a poor measuring stick by which to judge the patronage that can be expected of a feeder service laid out to meet the specific travel needs of the people who live in the smaller cities and towns.

CAB member Josh Lee has pointed out the inadequacy of this approach by saying: "I cannot agree with those who continue to insist that there will be no phenomenal increase in aviation after the war. They take a certain percent of the passengers who, before the war, crossed the Atlantic by steamer, first-class, and a small percent of those who traveled steerage—add them together, project them, and say, 'this is the maximum number of passengers who can be expected to cross the Atlantic after the war.' It would have been just as logical to have determined how many people crossed the American desert by stage coach, projected that figure, and then announced, 'this is the minimum number of passengers who may be expected to cross the United States by rail.'"

Also, Martin Taitel, a research analyst for the CAA has pointed up the ultra conservative market surveys made in the early days of the automobile by people who tried to project its utility by analyzing the actual use then being made of the buggy and carriage. Some of their estimates of the number of automobiles that could be sold annually were considered fantastic at the time—but proved to be a very small percent of the actual volume of manufacture a few decades later.

Many journeys not made at all now would be made if suitable transportation were available, but the volume of this extra traffic only can be "guesstimated". We can imagine that Farmer Brown who has a chicken ranch at Concordia, Kan. would attend a poultrymen's association luncheon in Kansas City if that 200-mi. trip could be made without interfering with the daily chores around the ranch. Mrs. Brown would come in more often to do her shopping, and Junior could be taken to see that Kansas City specialist about his ear trouble.



All studies of transportation indicate the large amount of travel between the satellite towns and their trade area center. This type of traffic can be tapped only by a local air service laid out to fill the needs of the residents of the satellite communities. To estimate the volume of this feeder airline traffic by using long-haul traffic records is obviously too conservative. Thus the profits to the government from establishing a system of feeder airlines would be much greater than the amount shown in the previous articles.

It has not been possible to combine local and long-haul transportation in any other means of transport. We wouldn't expect the *Queen Mary* to be used to bring passengers across the Atlantic and then to deliver them to the dozen or more cities along our Eastern Seaboard. Nor would the Twentieth Century Limited or the

Super Chief be used to carry local or commutation traffic between the larger cities and their suburban towns

In the air, too, different types of traffic will be carried in different vehicles It just doesn't work to land transcontinental planes at Concordia The schedules are set for the convenience of larger cities farther away and would not fit the local needs. Nor would they be reliable or dependable enough for local use, because any delay occurring anywhere along the transcontinental route might cause Farmer Brown to miss his luncheon engagement.

But, so far there has been no separation of local and long-haul traffic in air transport The only available type of service has been long-haul

Thus it becomes apparent that feeder service is to be a separate operation from long-haul or trunk line service. Different equipment, traffic, and operating procedures will require a different operating organization from top to bottom

In the other forms of transport, except rail, the separation is so complete that there is little if any economy in having both operations conducted by the same operating company In the case of the railroads, the two types of equipment used for the two kinds of traffic must use the same tracks But this reason for having one company furnish both kinds of service does not apply in air transportation.

It is obviously quite possible to have the same management own and control the two separate operating organizations An organization making fine watches and one manufacturing concrete mixing equipment could be under the same management, too. But it would be an unusual group of men who could understand the management problems of both businesses As a general rule, the efficiency of management deteriorates when its efforts are divided between unrelated activities

The difference between carrying long-haul and short-haul air traffic is not as great, of course, as that between the manufacture of watches and concrete mixers But there is still a very substantial difference. To begin with, different and specially designed aircraft will be required for feeder operation It follows that there will be a need for a separate staff of pilots who are expert on operating this aircraft and who are thoroughly familiar with the flight procedures necessary. These different operating procedures will require separate dispatching and flight control personnel.

It also follows that maintenance and overhaul will be different, with different personnel, separate tools and shops, and different spare parts and equipment. Even the traffic departments would need different people to solicit the two kinds of traffic. The printed literature, posters and advertising would be separate because it would be aimed at a different market.

A trunk line could, it must be stated, establish a separate division to operate feeder service This separation could extend on into management, and conceivably a good operating job could be done for each type of service But the arrangement would not result in greater economy—chances are that the feeder operation would be neglected, that it would become a stepchild, so to speak, while the long-haul operation would rate more prestige and management attention Thus the more capable personnel would be drawn away from the feeder operation and it would be left with inferior direction.

But there are a number of other reasons why it is in the public interest to have the feeder network operated by independent operators. Probably the most valid of these is the attitude of the trunk airlines toward feeder service, as expressed by their managing officers. By and large they are just not interested

As would be expected, policies vary with different companies, but though great efforts are being made by all the organizations to expand their long-haul services, only a very few of the smaller ones are willing to provide feeder service. To put over something new requires, first, an open mind and, second, a belief in the project. From public statements and from the positions taken in the recent CAB regional hearings, it is obvious that, with few exceptions, the trunk airline managements have neither.

It is an accepted economic principle that a new type of business can best be promoted and developed by an organization whose primary purpose is the operation of that business Development of feeder airlines is in itself a big job and will require the full-time attention of its management. Certainly development of such lines is too big a job for a part-time management that has repeatedly shown a lack of interest

Another important reason for independent feeder line operation is the problem of controlling competition between the two or more trunkline operators presently serving each of the larger trade centers which form the logical hubs of feeder systems. In the interest of economical operation, it will be desirable to have all feeder routes radiating from any one center, such as Chicago or Atlanta, operated by the same feeder operator The economy of size cannot be realized otherwise. If any of the trunk lines serving a trade center should be franchised for the feeder operation, it is logical to expect competitive practices that might not be in the public interest.

Traffic generated on the feeder routes would arrive at the center already ticketed for more distant common points of service over the operator's own trunk lines, regardless of whether the schedules were the most convenient or whether the services were more acceptable By adjusting its own feeder and trunk line schedules, it could be made very difficult for passengers to use competing services.

Thus the feeder operation would become a weapon of competition and a means of generating long-haul traffic. An operation designed to accomplish this purpose would fail to serve the real needs for local and short-haul transportation Only an independent operator could be expected to approach this problem from the standpoint of public need.

In the bitter fights for new routes now raging between the existing air carriers, the urgency of protecting the sources of their traffic is revealed Frequently, smaller towns already having air service are applied for not because the towns need extra service, but because the new applicant wants to get a share of the long-haul traffic originating from them.

If trunk lines were to operate feeder services, this practice would continue, possibly until each carrier operating into a trade area center also would run a feeder service to each satellite community Such a pattern would, it is felt, be very uneconomical, but would be a logical result of each carrier's efforts to protect its long-haul traffic at the source

An independent operator would be free to fully develop the local and short-haul traffic by rendering the maximum amount of efficient service to the public His schedules would connect impartially with trunk line schedules to provide the greatest convenience to his passengers

Actually some trunk airlines have maneuvered themselves into a very odd position as to their feeder airline policies. They realize that it isn't very practical for them to go after local traffic Too, their energies and resources presently are being absorbed in plans for the expansion of long-haul operations But they don't want new operators in the air transport field, so they have taken the position that the nearly one-third of our population living in the smaller cities and towns should not have air transportation.

Usually in considering the need for feeder service a study is made of the travel requirements of the small towns to which service is being extended Actually this is only half the story The people living in the larger cities already receiving direct air service are being given an expanded and a more valuable service, too It has often been pointed out that feeder lines would bring direct air service to nearly an additional one-third of our population The third that is already receiving direct air service could go to a much larger number of places by air and consequently would be greatly benefited by feeder service

The greatest justification for a national system of feeder lines is their usefulness as transportation They can supply a service affording greater speed and convenience than any other media of transport But there are other national benefits that would result from establishing such a system at this time

A national air feeder system furnishing service to most of the towns large enough to support it would provide employment for a goodly number of our returning veterans—nearly as many as can be employed by the trunk airlines.

From our experiences during the early '30's we know how terribly expensive unemployment can be to the nation Our reconversion and re-employment process after the war will be difficult at best Here is a way to provide industry-supported jobs at little or no government expense National planning should take advantage of every opportunity to create additional self-supporting jobs as a means of avoiding the dole and WPA type of relief The amount of re-employment that feeder airlines can give is great enough to assume national importance.

This is doubly true because of the kind of jobs that would be provided. Our national defense will require that all phases of our aviation industry—developmental, production, and operational—be maintained at a high level

The public knows how small a reservoir of aviation technicians this country had at the time of Pearl Harbor Thus shortage cost us billions of dollars The greatest lesson we can learn from this war is the appalling cost of not keeping our weapons ready. Our greatest weapon is our aviation know-how.

Because of its strategic importance, our aviation industry must be maintained, even if it does not appear to be self-supporting. No bets should be overlooked that will help to make it so. Feeder airlines, of course, would employ many pilots, mechanics, and other operations people But for each person directly employed, at least three would be needed to build the airplanes, the engines, the accessories, the instruments, and refine the fuel. Back of these would be workers to produce the raw materials, steel, aluminum, rubber, and agricultural products, and also

the tradesmen to supply and serve the families of all these workers Thus the total employment resulting from feeder airline operations would be large enough to materially help solve our postwar unemployment problems

We are living in a technological age. It is necessary that we lead, not only in research and development but also in the use and application of these technical advancements We have seen the great and wealthy nation of China kicked around by a much smaller nation which is inferior in every way except that it is more advanced technologically.

Our battle casualties in this war have been much less than those of the enemy One reason for this is that our men are more mechanically minded—a great help in fighting a mechanized war. We must remain the most mechanically minded nation even while we work for a permanent peace.

When we contemplate the destruction that has been rained on other cities of the world, we know that we must never allow another people to be more advanced aeronautically than we are. If our people are to know and understand aviation, it is of national importance that we provide means for them to use it—a good enough reason for extending air transport to our smaller cities and towns

This would be necessary even if substantial government expenditures were involved As we have seen in an earlier article, little if any subsidy will be needed, a fact which makes feeder airlines a national necessity

Aircraft Investors Seen Facing Lower Dividends

By RAYMOND L. HOADLEY, *Financial Editor, Aviation*

But our financial analyst considers this a healthy, normal condition between war and peacetime operations—one that should not greatly affect equity values.

WHEN THE DIRECTORS of United Aircraft decided last month to reduce their regular June dividend from $1.50 to $1 a share, Wall Street brokers immediately advised their clients to expect a general downward trend in dividend payments by aircraft companies. They were probably right.

United Aircraft holds one of the strongest positions among aircraft makers in more ways than one, so when this big integrated company reduces its stockholder payments to the tune of $2,656,000 annually, it is not only news but also an action bound to influence the near-future dividend policies of the rest of the industry.

As a matter of fact United probably would be about the last aircraft company that Wall Street would pick to cut its dividend. Its earnings for the first quarter of 1945 were published shortly before directors took dividend action and showed profits of $1.21 a share on sales of $165,000,000. (Back in 1936 when United declared its first dividend, sales for the entire year came to only $22,000,000 while earnings were equal to 76c a share.)

United has made an enviable dividend record for a company in this comparatively young industry. Formed in 1934 through the reorganization of the old United Aircraft & Transport Corp., it was one of the first aircraft concerns to place its common stock on a regular dividend basis. Payments have been made in every year since 1935.

But there is more significance than its dividend record behind United's new ultra-conservative policy. The company has back of it some excellent banking connections. National City Bank of New York, second largest bank in the United States, was in on the company's formation, and Gordon Rentschler, president of National City, is a brother of Frederick Rentschler, chairman and a founder of United. Joseph P. Ripley, one of the directors of United, is chairman of the investment banking firm of Harriman, Ripley & Co., and he has been active in the past financing of United Aircraft, United Air Lines, and other aviation companies.

Early in the war, United's directors foresaw that its capital was inadequate for the wartime expansion that lay ahead. So in the forepart of 1942 an issue of more than $25,000,000 in preferred stock was sold to provide additional working capital. By the end of 1944 the company had current assets of $182,675,000 against current liabilities of $88,675,000. At the same time net worth stood at $94,000,000 compared with $74,000,000 in 1942 and only $18,000,000 in 1939, the year United first felt the impact of large British and French war orders.

And as far as reserves were concerned, United had set aside $2,726,000 from profits by the end of 1944 as a reserve for write-offs of excess expendable tools and supply inventories as well as $32,475,000 as a reserve against reconversion to postwar conditions.

Nevertheless, while sales and earnings still reflect wartime conditions, United has taken the lead in reversing the aircraft dividend upward trend, a rise which has continued steadily since 1939. In so doing Chairman Rentschler explained that with the end of the war in Europe and the closer proximity to final victory, extremely serious problems confront the aviation industry in termination and reconversion.

While he feels that in time these problems will be effectively solved, he believes that the cornerstone of our air power is a going, healthy aviation industry, and the "directors and management of United Aircraft believe that through this period a strong financial position must be maintained."

Thus it seems probable that most of the other aircraft companies shortly will follow United's lead and cut their dividends, even though some of them may continue earning their present payments by a comfortable margin as long as the Pacific war lasts.

What will be the effect upon stockholders of wholesale dividend reductions aside from the obvious loss of income? Probably very little since the stock market never has paid much attention to the wartime dividends disbursed by the aircraft companies—or to their wartime earnings, either, for that matter.

It is interesting to note that following the reduction in United's dividend the stock continued selling part way between the high and low for the year.

(*Turn to page 250*)

Utility Is the Range-Finder In Civil Plane Market Forecasts

By NEIL B. BERBOTH, *Development Div., Fairchild Engine & Airplane Corp.*

Here is a vital approach to the problem of gaging what part of the consumer's income our aviation industry may translate—via tax and competitive factors—into a thriving personal-craft business.

TO ADEQUATELY ASSESS possible personal aircraft markets it is first necessary to define utility as applied to personal transportation, for the personal plane must be regarded as a means of moving people from one place to another.

People travel for one of two reasons: Business or pleasure. These, in turn, represent three classes of utility.

First, there is *ultimate utility*, the ability to go anywhere at will, either between specific places for a particular purpose, or merely traveling for the sake of travel. Second, there is *limited utility*, the ability to travel between specific places for a particular purpose or merely to travel for the sake of travel, but with limited ability to go anywhere at all either because of speed or medium of travel. Third, there is *restricted utility*, the ability to move about merely for the purpose of moving, with no specific place to go and little object in going, restricted by speed, medium of travel, service facilities, and avigational facilities.

To date the automobile has achieved the closest approach to ultimate utility on land, limited only by its speed, and suitability of highways, from accomplishing longer-distance business and pleasure trips within restricted time periods. Personal airplane transportation to date has, by and large, achieved its best measure of success with restricted and to some extent, limited utility—that is, cross country flying for pleasure or flying for sport with no particular destination and purpose other than the accomplishment of moving through the air.

It has been, for most people, a sport or end in itself, rather than the means to an end. This characteristic must change before a reasonable degree of ultimate utility may be achieved. There is the exception of the flying salesman, usually selling aviation products, and the executive owner constituting a special class and demanding a higher type of plane than the true personal-owner type.

Neil Berboth of Fairchild's Development Division not only injects some new thoughts on estimating personal plane market potentials, he presents new methods of reaching them. Realizing that aircraft manufacturers will be competing with many other producers for that all important consumer's dollar, he goes further to present ranges based on penetration of the market whereby individual producers, distributors or dealers can, on the basis of their own positions, more clearly judge what they may anticipate in the battle for sales.

The question, then, is what degree of utility may feasibly be attained by the airplane in the near future, and what requirements must it meet in order to attain this utility? Here lies the possibility of injecting some new thought into a well worn subject.

To attain ultimate utility, a vehicle must be capable of operating to a place within short walking distance of any spot in urban, rural, and farm areas where people have a community of interest. This requirement eliminates the present personal airplane as a completely utilitarian transportation unit, unless sometime in the future some radical design innovation is achieved, such as the helicopter objectives. But we are concerned here with airplanes as they may be conceived in the near or postwar future, and for that reason must dismiss the idea of the airplane's attaining ultimate utility.

Therefore, if personal aircraft markets are to provide substantial means for the support and continued development of the aircraft industry we must look beyond prewar concepts for our potential markets.

Strong incentives for owning an airplane which may provide little practical every day utility and which will require additional investment above utilitarian vehicles must be

TABLE I — Money Spent For Personal Transportation (1952 As Typical of 1947-57 Decade)

Income Level	Consumer Units (000)	Average Income	Income for Current Consumption	Approximate % Using Personal Transport¹	Annual Amount Spent for Personal Transportation
Under $1 000	12 350	$625	$850-970	35%	$133-173
$1 000-2 500	17,380	1 850	970-2120	58%	175-265
$2 500-3,500	5 650	3 100	2120-2980	68%	266-338
$3 500-5,000	6 800	4 200	2980-3800	75%	338-384
$5 000-10 000	1,985	7 000	3600-6000	95%	384-538
$10,000-20,000	347	16 000	6000-10 075	97%	538-815
Over $20,000	148	40 000	Over $10,075	100%	Over 815
All Levels	46,955	$1,955	$1 860	69%	$211

¹ J. H. Geisse, "Postwar Outlook for Private Flying"

sought largely in the field of limited utility. If the incentive for ownership can be stimulated in such fields as sports, touring, and long-distance business travel, people may gradually find more utility for their aircraft.

Americans have long accepted recreational motoring as a part of the national life, they make considerable use of the automobile for long business trips. It is estimated, for example, that 12 percent of the annual auto mileage —29 billion car miles—is in trips of over 200 mi, of which 25 percent is business travel. Approximately 7 percent, or 16½ billion car miles annually is used for trips of 30-40 mi, of which 75 percent is Sunday driving, with the balance business trips. Approximately 640,000 inboard boat miles a year are made in 30–60 mi trips. Thus about 19 percent, or 46½ billion vehicle miles annually can be said to represent potential mileage which may physically be performed by the personal airplane.

It must be remembered, however, that the automobile is purchased primarily because it provides almost ultimate utility, and not for purposes representing limited and restricted utility, although it is used for such purposes. This factor will exercise a restrictive effect upon the potential market for personal aircraft.

What are the requirements of the personal travel market? To understand this, we must look back to its beginning. The automobile brought the speed, flexibility, and endurance necessary to bring long-distance personal travel within popular reach. If the personal airplane is to take an important place in our national economy it must be efficient and practical in these three respects as far as touring and business travel is concerned.

The airplane possesses greater inherent speed than the automobile, leaving flexibility of operation as the quality to be attained in order to achieve an expanded market potential, and it is this problem which faces the aircraft industry today. The problem has many aspects, most important of which are:

1. Necessity for many strategically located flight strips, water ports and airparks, so that no inhabited or desirable spot in the United States will be more than a few miles distant. It has been estimated that this goal might require approximately 20 000 such ports. All ports should be lighted for night flying operations.

2. Necessity for complete ground service facilities at all or almost all, of these ports similar to that provided the motorists.

3. Necessity for simplified aviation facilities for day and night contact flying, such as visual lighted location markers; etc.

4. Necessity for simplified airplane operation.

5. Necessity for simplified rules and regulations governing private flying.

6. Necessity for improvements in safety of operation of personal aircraft.

7. Necessity for inexpensive highway transportation facilities at all or almost all, flight strips and airparks — such as low rate auto rental services, taxis, and bus lines.

TABLE II—Annual Amounts Which Could Be Spent To Own And Operate A Personal Plane

Income Level (Dollars)	Approximate % Using Personal Operated Transportation	Consumer Units (000)	Annual Amount Spent for all Personal Transportation ($)	Annual Amount Spent for Auto Transportation ($)	Annual Amount Allowed for Personal Plane Transportation ($)	Maximum Selling price of Airplane ($)
Under 1 000	35	6,080	142-187	70-90	72-97	*
1,000- 2 500	62	10 076	187-225	90-145	97-140	*
2 500- 3 500	68	3 840	365-362	145-180	140-172	350-430
3,500- 5,000	75	5 100	362-411	180-200	172-211	430-530
5 000- 7,500	95	1,200	411-460	200-220	211-270	530-675
7 500-10,000	94	440	460-540	220-240	270-400	675-1 000
10,000-15,000	67	336	540-1,100	240-300	400-800	1,000-2 000
15 000-25,000	100	245	1,100-2 450	300-450	800-2,000	2,000-5 000
25 000-35,000	100	53	2,450-4,000	450-720	2,000-3 280	5,000-8 200
35 000-50 000	100	40	4 000-6-000	720-1 000	3,280-5 000	8,200-12 500
Over 50 000	100	20	Over 6 000	Over 1 000	Over 5 000	Over 12 500
		27,439				

* Assumption is made that there will be few, if any, airplanes priced under $350.

Note: Statistics on Consumer Units obtained through National Industrial Conference Board, Economic Almanac. Consumer units in various income levels over 5 000 based on similar relationship to 1935, National Resources Committee, Economic Almanac, NICB. Assumption is made that persons in income levels over $7,500 will spend a higher percentage for personal transportation because percent of expenditures for subsistence is considerably lower. Automobile prices obtained from *Automobile Facts and Figures*, Automobile Manufacturers Association.

times that postwar economic conditions may be reasonably healthy, that postwar tax rates will be decreased substantially from present levels that the established prewar trends of population, family groupings, and family income continue—then it can be estimated that during the decade 1947–57 approximately 11 million consumer units could spend $265–385 annually for personal transportation; 2 million consumer units could spend $395–540 annually, 350 thousand consumer units could spend $540–900 annually, and 150 thousand could spend over $900 annually. This would reflect an increase in personal transportation buying power of approximately 32½ percent over 1935–36 levels, and a decrease of approximately 15 percent under 1942 levels.

The average annual expense of owning and operating an automobile or small personal plane has been estimated at approximately 40 percent of initial cost. Ordinarily, the result of increasing expenditures for personal transportation has been the purchase of more expensive cars and increasing mileage operated; and to a lesser degree the same is true of the purchase of boats and, more recently, personal aircraft.

Let us assume the best possible circumstances—that is, that utility may be increased to the point where the American people will want to fly for long-distance business, pleasure, and sport to the extent that they will spend from $200–700 less for new cars, or would buy used cars from 2 to 3 yr older than they would normally operate, and that increasing non-subsistence expenditures would include increases to 9.1 percent of consumption dollars expended for personal transportation.

If this were the case, and ownership of a plane presupposed ownership of an automobile, then approximately 7,000,000 individuals may afford to operate a used airplane, or else a new airplane only through the medium of flying clubs and airplane rental; another 732,000 may afford to own and operate their own new airplane costing from $1,200–2,500 or else operate a higher priced new airplane through the medium of flying clubs; another 255,000 could afford to own and operate a new $2,500–5,000 airplane or else operate a more expensive airplane through flying clubs; and another 135,000 persons in the highest income brackets may afford to own and operate new aircraft costing from $5,000 to about $10,000. Approximately 12,000 persons may afford luxury airplanes of greater cost.

This, then, appears to be the potential market for the 1947–57 period, in terms of maximum numbers of consumers and what they may afford. How many of this total will fly depends largely upon the utility and safety of personal airplane operation which we in the industry can achieve.

Utility is of prime importance. On the basis of the foregoing estimates, it appears that a substantial dollar volume market may exist for all classes of personal aircraft, costing from $1,200–10,000. The extent to which this broad market may be penetrated depends upon the usefulness of the personal airplane as a transportation unit.

Majority of the many estimated personal plane markets—ranging from 100,000 to 450,000 within ten years after the war—undoubtedly are based on the assumption that at least a good measure of increased utility will be achieved.

The lowest estimates generally assume that at the start of the postwar period utility standards may be similar to those of prewar days, with costs higher due to increased development, labor, and material charges. They also assume that, as the decade progresses, utility will increase fairly substantially, while costs will decrease more slowly as production increases and designs become stabilized.

The 300,000 estimate—the average of the range just mentioned—apparently assumes that cost and utility standards will improve perceptibly immediately following the war and that, as the decade progresses, utility will increase rapidly while cost standards decrease to levels approximately 50 percent below prewar levels.

It is difficult to predict which estimates may prevail. Either extreme may be realized, and any prediction would reflect the viewpoint of the maker, based upon his evaluation of the many factors involved, including surplus, the possibilities of overcoming increasing material and labor costs, and the speed and facility with which the industry and government may attack the problem of utility. There are many divergent views within the industry upon these problems.

However, in order for the estimate of 300,000 registered personal planes within ten years to be realized, it would be necessary for about 25 percent of the total potential of over 8 million consumers who may afford to own or, if not, to rent new airplanes, to do so, either by purchasing new planes personally or through flying clubs, or by renting new airplanes for long-distance travel purposes.

This compares with a prewar market penetration of about 2.5 percent and means that the public interest in personal flying must be developed to a high degree; that substantial and ever increasing utility and safety standards be attained, and that cost standards be lowered considerably to a point

TABLE III—Estimated Potential Personal Airplane Market, 1947-57

Number of Customers	Income Level ($)	Aircraft Price Range	Total Potential Dollar Volume (Millions of Dollars)	% of Max. Potential Market (Airplane Units	Approx % of Max Potential Market (Dollar Volume)
12,000	Over 25 000	Over $10,000	Over $120z	1 6	5 7z
135 000	Over 10,000	$5 000-10 000	$675-1 350	11 8	28 4
255,000	10,000-25,000	$2,500- 5,000	$637-1,275	22.3	20 6
732,000	2,500-15,000	$1 200- 2 800	$878-1,830	64.4	3e 1
1,134,000				100 0%	100 0%
Number of Customers	Income Level ($)	Aircraft Price Range			
7,800,000	2,800-10 000	$800-1,200 or $1,200-5,000			
16,000 000	Under 2 800				
27,439 000	Grand Total Customers				

z Average Aircraft Price Assumed as $20 000

Explanation

Second Hand Airplane:

New or second hand airplane through flying club. Expenditures $75–175 annually for new or second hand airplane rental.

TABLE IV—Estimated Potential Personal Airplane Market, 1947-57, At Varying Percentages of Total Potential Market Penetration

Total Aircraft—	Penetration 5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	66,800	133 800	267 600	401 400	535,200	669 000	802,800	936,600	1,070 800	1,204,200	1,338,000
Aircraft — Personal use	56 700	113 400	226 800	340 200	453,600	567 000	680 400	793,800	907 200	1,020,600	1 134,000
Aircraft — Flying clubs	7,300	14,600	29,200	43,800	58 400	73,000	87 600	102 200	116,800	131,400	146,000
Aircraft — Fixed base operators	2,800	5 800	11,600	17,400	23,300	29,000	34,800	40 600	46,400	52,200	58,000
Aircraft — Over $10 000	800	1,800	2,400	3,600	4,800	6 000	7 200	8,400	9,600	10 800	12,000
Aircraft — $5,000-10,000	6,786	13 570	27 140	40,710	54,280	67 850	81,420	94,990	108,560	122,130	135,700
Aircraft — $2 500-5,000	13,600	27,350	54,700	82,140	109,500	136,900	164,280	190,660	219,040	246,420	273 800
Aircraft — $1 200-2 800	45 826	91 650	183 300	274,950	366 600	458 250	546 900	641,583	732,000	824,850	916 500

TABLE V—Estimated Potential Personal Airplane Market 1947-57, At Varying Percentages of Total Potential Market Penetration (Dollar Volume)

	Penetration—										
	2%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Total (000)	$133,100–$262,700	$266,200–$526,900	$532,400–$1,060,000	$811,000–$1,578,100	$1,064,800–$2,100,000	$1,342,100–$2,630,900	$1,932,000–$3,165,200	$1,830,460–$3,682,900	$2,129,600–$4,200,000	$2,432,150–$4,728,300	$2,484,500–$4,261,000
Aircraft — Over $10,000 (000)	$ 12,000	$ 24,000	$ 48,000	$ 72,000	$ 96,000	$ 120,000	$ 144,000	$ 168,000	$ 192,000	$ 216,000	$ 240,000
Aircraft — $5,000–10,000 (000)	$ 33,625–$ 67,500	$ 67,250–$135,700	$135,700–$271,400	$203,550–$407,100	$271,400–$542,800	$ 339,250–$ 678,500	$ 407,100–$ 814,200	$ 474,950–$ 949,900	$ 542,800–$1,085,600	$ 610,650–$1,221,300	$ 678,500–$1,357,000
Aircraft — $2,600–5,000 (000)	$ 34,200–$ 68,400	$ 68,400–$136,800	$136,800–$273,600	$205,200–$411,000	$273,200–$547,200	$ 342,500–$ 685,000	$ 411,000–$ 822,000	$ 477,500–$ 955,000	$ 547,200–$1,094,400	$ 615,600–$1,231,000	$ 684,200–$1,370,000
Aircraft — $1,200–2,500 (000)	$ 84,000–$114,500	$108,000–$229,000	$218,000–$458,000	$330,000–$688,000	$436,000–$918,000	$ 541,000–$1,147,000	$ 660,000–$1,378,000	$ 770,000–$1,610,000	$ 872,000–$1,832,000	$ 980,000–$2,060,000	$1,083,000–$2,294,000

where two-, three-, and four-place aircraft of higher utility may be purchased for from $1,000–2,500.

An additional important point must also be made. The capacity of the industry to achieve increasing production and reduced costs of commercial and personal planes while overcoming problems of personal plane utility will depend indirectly on postwar military aircraft production. If we keep a sizable Air Force and maintain a reasonable scale of research, development, and replacement production, we should, as a healthy and united industry, be able to meet the challenge of postwar commercial and personal markets for new and better aircraft.

To complete the picture, here is the method used for estimating the potential consumer market for personal aircraft.

Estimates of buying power are made on the basis of consumer units, which represent the total of family and individual buying units in the United States. For instance, in 1941 there was a population of 130,100,000, excluding institutional. This total population was broken into 33,000,000 family units and 8,550,000 single individuals, making a total of 41,550,000 consumer units.

According to projections made by the National Resources Committee, there will be in 1947 a total population of approximately 139,500,000, and in 1957, 148,500,000. Since 1900 there has been a steady increase in the number of families, accompanied by a consistent and regular decrease in the size of the family unit. If it is assumed that this trend will continue in the postwar period the consumer units in the postwar decade (assuming 1947 as first year of peace) will appear as follows:

Year	Population (000's)	Persons per Family	Total Family Units (000's)	Total Single Individuals (000's)	Total Consumer Units (000's)
1900	75,285	4 89	14,538	7,102	21,640
1941	130,400	3 68	33,000	8,550	41,550
1947	138,350	3 60	36 000	10,350	46,350
1952	141-250	3 38	38 000	10,350	49,350
1957	148,150	3 20	42,000	10,350	52,350

The population figures for 1947, 1952, and 1957 assume that the standing Army, Navy, and Air Forces will be higher than in prewar years, so that total institutional population will reach a high of 2.25% of total population.

National income has increased consistently since the turn of the century, from $677 million in 1900 to $90 billion in 1941, with the customary lapses during depression periods. Due to war conditions it went to $140 billion in 1943 and probably will go higher in 1944–45. If it is assumed that reconversion and economic readjustment can be accomplished with reasonable facility resulting in reasonably healthy economic conditions, and that national income may return to a level of approximately $10 billion above 1941 levels, increasing slowly with little fluctuation during the decade to approximately $110 billion in 1957—then the individual income trend would appear as follows:

Year	Per Capita Income	Total Consumer Units 000's	Income Per Unit
1900	$212	21 550	6738
1941	675	41 550	1 660
1947	718	46 350	1 990
1952	727	49 550	1,350
1957	740	52 550	1.685

Taking the 1952 figures as typical of the decade for the purpose of estimating the 10-yr. market potential, assuming that the relationship of consumer units and income brackets will return to 1940–41 standards, and further assuming that the 20-yr. trend of consumer expenditure for personal user-operated transportation will continue at 8.5 percent of the consumption dollars, we then arrive at the conclusions shown in Table I.

It has been estimated that the yearly cost of operating either high or low-priced planes or automobiles ranges from 40–60 percent of the purchase price. (J. H. Geisse, *Postwar Outlook for Private Flying.*) An optimistic assumption is that the over-all national average might be the lower, 40 percent. On this basis, the following table indicates the price automobile which could be owned and operated by consumers in the various income levels:

1952 (As Typical of 1947–57 Decade)

Income Level	From	Range Car Age	To	Car Age
Under $1 000	$330	Over 3	$440	2–3
$1 000–2 500	440	2–3	665	new–1
$2 500–3 500	665	new–1	850	new
$3 500–5,000	850	new	990	new
$5,–10 000	990	new	1,350	new
$10 –20 000	1,350	new	2 280	new
Over $20,000	Over $2 280	new		

The above prices represent an increase of approximately 32½ percent in transportation buying power over 1935–6 levels, and a decrease of approximately 15 percent under 1942 levels (assuming automobiles were available in 1942). In the past, as income expanded, the proportion of current consumption dollars expended on transportation has been maintained through increased new car purchases, purchase of higher-priced cars, and purchase of other personal transportation luxury items such as boats and, more recently, airplanes.

Another pronounced trend has been the increasing ratio of expenditures above subsistence only. The rate of increase for the past 30 yr. has been approximately 21 percent per decade. When the relationship of personal transportation expenditures to total expenditures is considered this trend would theoretically amount to about a 7% increase in consumer dollar expenditures for personal user-operated transportation during the decade 1947–57. However, it has been established that the consumer may be expected to adjust his budget to allow for expenditures of 8.5 percent of his dollar for personal transportation, and this possible increase would normally be diverted to other non-subsistence items, such as foreign travel, education, recreation, etc.

The assumption is made that increased utility of the personal airplane may reverse these two normal trends to the extent that:

1. As income per consumer unit increases, consumers would operate used automobiles 2–3 yr. older than normally, or operate new automobiles costing from $200–700 less, or in the case of higher income consumers, operate one instead of two new automobiles or two low cost automobiles; and,

2. As non-subsistence expenditures increase in proportion to subsistence expenditures, such increases would include an increased percent of consumption dollars expended for personal transportation, to the extent of approximately 9.1 percent of total consumption expenditures.

On the basis of these assumptions, the results shown in Table II represent the annual amount which could be spent owning and operating a personal airplane, and the price airplane which this annual amount would support.

Undoubtedly there will be many persons in the lower and medium-high income brackets who will spend more than the amount indicated in Table II for personal aircraft, especially where families are small and savings, such as war bonds, have been established over a period of time. These are the people who will possess a more-than-average desire to fly as a hobby or pastime, and they will represent the backbone of the market. Their numbers are impossible of estimation.

However, the vast majority will tend to fall within or slightly above the price brackets indicated when effect of savings is considered. The principal reason is the strong desire of persons in all income levels for a variety of luxury goods and services, and the desire for a personal airplane will vie for consideration with other items, from larger homes to washing machines, until and unless the utility of the airplane is increased to the point that it becomes a practical necessity.

Allowing proper weight for these factors, and giving consideration to the effect of established long term savings in all income brackets which may allow consumers to "stretch a point", Table III may define the potential market for personal airplanes during 1947–57, on the basis of the assumptions developed heretofore. The term consumer unit is changed to "customer".

Estimates of purchasing power for all groups are based on the assumption that the tax rates in the postwar period will be substantially decreased from present levels.

Although Table III indicates that aircraft in the price range from $5,000–10,000 have almost as great a potential dollar volume market as aircraft priced from $2,500–5,000, it is necessary that the higher priced aircraft possess *distinct advantages* over the lower priced planes in order that this potential market be realized.

This would be the case throughout all four price ranges, and it accentuates the effect which cost and quality competition will have on the potential market for various aircraft. Among the qualities which may be the criteria through all price ranges are passenger and baggage capacity, cruising range, cruising speed, landing speed, simplicity of operation and flying characteristics, relative safety of operation, instrumentation, appearance, ease of maintenance, comfort, and flexibility of land and water operation.

In estimating the potential personal plane market at varying percentages of potential sales, it is necessary to make several arbitrary assumptions, as follows:

1. That 10 percent of the total of 7,300,000 customers who may afford new airplanes only through flying clubs will do so, and that there may be an average of five persons per club; resulting in a new airplane market potential of 146,000 units. That about 10 percent of these customers may purchase aircraft priced from $2,500–5,000, and that 90 percent will purchase aircraft priced from $1,200–2,500.

2. That 75 percent of total potential pilots may take approximately 25 hr. dual and solo instruction before purchasing aircraft; that there will be approximately 313,000 capable pilots in 1947—63,000 civilian registered and 250,000 military; that utilization of aircraft for instruction of these pilots may average 500 hr. annually; and that new aircraft will be utilized for instructional and rental purposes, resulting in a new airplane market potential of 58,000 units, of which about 2 percent may be aircraft priced from $5,000–10,000, about 8 percent priced from $2,500–5,000, and about 90 percent priced from $1,200–2,500.

3. That the balance of average annual utilization of aircraft by fixed base operators (approximately 250 hr.) will be sufficient to provide instructional and rental services to those 19 million customers who may not afford new or second-hand aircraft, but who may afford a few hours of instructional and rental flying annually.

No attempt is made to estimate new aircraft yearly production levels at varying percentages of market penetration, because of the multitude of unknown factors involved, such as disposition and life of surplus aircraft, life of new and prewar personal aircraft, intervals at which trade-ins will be effected, numbers of customers who will discontinue ownership after an indefinite period, etc.

Table IV shows the estimated potential personal airplane market vs the percentage penetration of the total potential market, based upon the assumptions developed heretofore. All figures are estimates only, and the reader may, with the facts and figures contained herein, make different and varying assumptions and derive his own estimates.

Table V gives the 1947–57 estimated potential market, at varying percentages, in dollar volume, while Table VI gives estimated characteristics of postwar personal planes, compiled and estimated on the basis of information and specifications released by various manufacturers to date.

TABLE VI—Postwar Personal Planes Estimated Characteristics

Horsepower Class	Estimated Characteristics	Passenger Capacity 1	2	3	4
40–65 hp.	Vas	70–90 mph			
	R	200–400 mi			
	$	$800–1,000			
	Ca	$400–600			
	Chr	$2 70–4 00			
	Cam	4 5–5 0¢			
65–100 hp	Ver		80–110 mph		
	R		200–400 mi		
	$		$1 400–2 500		
	Ca		$400–1,000		
	Chr		$4 00–6 70		
	Cam		2 8–3 3¢		
100–150 hp	Ver		110–120 mph	100–115 mph	90–110 mph
	R		400–600 mi.	400–600 mi	600–800 mi
	$		$2 500–3 000	$3 000–4 000	$3 500–4 500
	Ca		$1 000–1 200	$1 200–1,500	$1,400–1 800
	Chr		$5 70–8 00	$8 00–10 70	$9 00–12 00
	Cam		3 3–3 8¢	2 9–3 4¢	2 9–3 0¢
150–200 hp	Ver		150–165 mph.	135–150 mph.	120–130 mph
	R		700–900 mi	600–800 mi	600–700 mi.
	$		$4 000–5 000	$5 000–6 000	$4,000–7,000
	Ca		$1 600–2 000	$2 000–2,400	$1 600–2,800
	Chr		$10 70–13 30	$13 30–16 00	$10 70–18 70
	Cam		3 8–3 8¢	3 5–3 8¢	2 4–3 0¢
200–250 hp.	Ver				130–180 mph
	R				700–900 mi.
	$				$7 000–9,000
	Ca				$2,800–3,500
	Chr				$18 70–24 00
	Cam				3 9–4 0¢

Ver = Cruising True Air Speed @ 60-70% Power
R = Maximum Range
$ = Selling Price
Ca = Annual Operating Cost — 150 hr. operation
Chr = Hourly Operating Cost
Cam = Operating Cost Per Stat Mi.

Note: Operating Cost include estimates of (a) Direct Operating Cost — Fue & Oil Maintenance Service, Replacement Parts, (b) Hangar Rental, (c) Depreciation, (d) Fairly Complete Insurance Coverage

MASS PLANE MARKET STARTS WITH SURPLUS

Money has already been made refurbishing and selling personal type aircraft made available through Office of Surplus Property—here's how it's been done and still can be done.

Biggest aircraft distribution job in nation is that which has devolved on RFC agency charged with moving some 20,000 surplus warplanes. Over 8,000 —including many advanced trainers such as those shown here—have already been reconverted and sold by fixed base operators. (Press Association photo)

By **JOHN FOSTER, JR.**, *Managing Editor, Aviation*

THE NATION'S BIGGEST aircraft marketing program now being conducted by the Reconstruction Finance Corp., designated by the Surplus Property Board as the agency for the disposal of aircraft, offers profit opportunities to dealers and distributors via two channels—through direct sales of planes, and through keeping their service organizations intact and busy repairing planes for sale.

This statement holds true on the basis of the record to date, for many alert operators have already re-sold many of the more than 11,000 planes which RFC and WTS have disposed of by sealed bid or, more recently, by fixed price. That additional profits can be made is evidenced by the fact that of the 20,000-odd aircraft now in surplus, approximately half are of types which might find service in the personal, fixed base operator, or transport fields. Both figures may be raised as more airplanes are declared surplus.

Considerable criticism has been leveled at the disposal agency but, RFC officials point out, none of the criticisms have been accompanied by tangible programs that can be made to work. Some of the criticism has been due to misunderstanding or lack of knowledge of the law—the Surplus Property Disposal Act—under which the program must be operated. While there is fairly wide leeway under the law, its basic principles are that the property must be moved.

RFC officials realize that, with so many airplanes, components, parts and accessories to be disposed of, any major move made will bring down the wrath of someone. As one official told AVIATION, "no matter what we do, somebody will say we're wrong, for the whole disposal program has some problems which simply can't be settled to everyone's satisfaction."

Recent changes in the over-all disposal set up put aircraft—along with all other surplus—under Hans Klagsbrunn, who heads up the new Office of Surplus Property, with Joseph P. Woodlock as executive director and James A. Garfield, who was chief of the surplus war Aircraft Division under Defense Plant Corp., as deputy director of aircraft disposal.

The new Aircraft Division, in turn, is divided into five sections. Aircraft Disposal, under E. L. Traylor; Parts & Components, under Col. A. E. R. Peterka; Educational Disposal, under Russell Heddleston; Maintenance & Salvage, under Stanford Stelle; and Administrative, under Thomas A. Waddin.

Following recommendations of the so called Pogue Report, made to the SWPA by the Surplus Aircraft Advisory Committee, surplus aeronautical products are classified under five headings: Class A, combat craft useful only for military purposes; Class B, transport craft, or larger planes useful primarily for scheduled operations; Class C, personal planes, those adaptable to private and fixed base operations; Class D, equipment and components, useful both for military and non-military purposes; and Class E, all planes and components not useful for either military or non-military purposes.

In operation, the program is being conducted along the following lines:

Aircraft declared surplus by the military are reported to the Aircraft Division in Washington, regardless of the location or classification of the craft. Lists of these planes are then sent to CAA engineers who indicate which types will be eligible for airworthiness certificates. Type-certificates are then issued for the eligible types. If the Aircraft Division so requests, the CAA will make tests of ineligible types to determine what changes or modifications will be necessary.

Prices of planes to be offered for sale come within a range established by formula—the lowest possible figure being the plane's salvage value, the top of the range being the "type price" which has been established as the result of experience gained in disposing of planes through the original sealed bid method.

The price formula has been worked out on the basis of original cost to the government, demand for the particular type, total time flown, time since overhaul of both engine and airframe, and other factors which make the final price determination a matter of routine for the field man.

Type price on the Cessna AT-17, for example, is $12,000 on planes costing the government from $28–32,000. From this $12,000, a flat $3,500 allowance is made toward reconversion costs on craft equipped with constant speed propellers and wings designed for a 5,400-lb gross weight. An additional $1,500 allowance is given for planes equipped with fixed-pitch wood propellers and/or wings designed for 5,100-lb gross weight. Minimum price on any AT-17 would be $3,900, the salvage value.

Type prices on Fairchild PT-19 and 23, Boeing PT-17, Ryan PT 22, and Naval Aircraft Factory N3N-3 types range from $875 to $2,400.

When a plane has been declared surplus it is delivered by the military to one of the 55 disposal centers operated by RFC. Twenty-four of these are designated as sales centers and are operated under contract by fixed base operators; 31 are sales-storage depots—former military training centers now owned by the RFC, which also are operated under contract. Both types and their locations are shown in the accompanying listings.

While an effort is made to have the planes delivered where they will be

SALES-STORAGE DEPOTS

Surplus War Aircraft Division
(As of Mar. 22, 1945)

Contractor	Field	Location	Disposing Lean Agency
Tye R. Bledsoe	Cimarron	Oklahoma City, Okla.	Kansas City
Willis Van Hassell	Hicks	Fort Worth, Tex.	Dallas
T. G. Walker	Bush	Augusta, Ga.	Atlanta
George Converse	Souther	Americus, Ga.	Atlanta
Jackson Hunter	Harris	Cape Girardeau, Mo.	St. Louis
Frank E. Hope	Augustine	Madison, Miss.	New Orleans
Darrell P. Maronde	Thunderbird II	Phoenix, Ariz.	Los Angeles
Lester B. Luttrell	Cal Aero	Ontario, Calif.	Los Angeles
Tyle W. Cadapee	Echeverria	Waskenburg, Ariz.	Los Angeles
John T. Wright	Hat Box	Muskogee, Okla.	Kansas City
W. N. Hearn	McNellar	Jackson, Tenn.	Atlanta
W. MacGraves	Grider	Pine Bluff, Ark.	St. Louis
Paul E. Wilcox	Ryan	Hemet, Calif.	Los Angeles
Robert H. Landers	Lamesa	Lamesa, Tex.	Dallas
Lee M. Cornue	Ponca City Mun.	Ponca City, Okla.	Kansas City
E. L. Ingram	Gibbs	Fort Stockton, Tex.	Dallas
Walter Kennon	Embry-Riddle	Union City, Tenn.	Atlanta
James E. Darby	Woodward	Camden, S. C.	Charlotte
George D. McCormack	Cuero Mun.	Cuero, Tex.	SanAntonio
Sam D. Williams	Thompson-Rothburn	West Helena, Ark.	St. Louis
W. O. Smith	Victory	Vernon, Tex.	Dallas
James W. Carlyle	Gary	Blythe, Calif.	Los Angeles
J. E. DeCosta	Arledge	Stamford, Tex.	Dallas
Charles E. Mears	Ryan	Tucson, Ariz.	Dallas
G. C. McGee, Jr.	Corsicana	Corsicana, Tex.	Dallas
Robert Gee, Jr.	Palmer	Bennettsville, S. C.	Charlotte
Ben White	Fletcher	Clarksdale, Miss.	New Orleans
William W. Kelly	Harvey Park	Sikeston, Mo.	St. Louis
J. P. Flynt, Jr.	Bruce	Ballinger, Tex.	Dallas
Ben H. Stroup	Municipal	Douglas, Ga.	Atlanta
Foster P. Forbes	Albuquerque Army Airfield	Albuquerque, N. M.	Denver

sold, this is not always possible and it becomes necessary to redistribute them to other sales points. This is done by contract, the ferrying contractor receiving 27¢ per mile for each plane. This has been found adequate to cover expenses due to time lost by weather and other causes and still leave a fair margin of profit. Sales Center operators receive from $12 to $15 per month per plane for outside storage. Out of this figure, however, the operator provides 24-hr. armed guard service, provides office space for disposal agency employees, and inside hangar space for a minimum of three planes undergoing inspection or repair.

The average quota is 30 planes per field so that prospective buyers will not only have a fair cross section of types available from which to choose, but several of the same type so that purchases within the budget can be made.

Most aircraft purchases to date have been financed by the buyers—mostly fixed base operators—but it is pointed out that financing is available through the Smaller War Plants Corp., and RFC itself is considering a time-payment plan for the program.

In one case an operator purchased a Cessna AT-17 for about the top price of $12,000, to which he added some $3,000 for reconversion and certification. Using this one craft—for which he has repeatedly refused offers ranging as high as $22,000—as a demonstrator, the operator has to date secured firm orders for 20 similar jobs at prices averaging $18,000. Thus his shop is being set up to handle reconversions on a line production basis.

The problem of reconversion and certification of surplus aircraft, particularly the PT and AT types, has been simplified by the Disposal Division's Engineering Section.

Working with CAA engineers at Bush Field, Ga., type certification tests are being run on approximately 20 plane types at a time to determine just what changes must be made in the craft to meet CAA airworthiness requirements. In some cases, especially with the more marketable PT and AT types, these changes are of a minor nature and can be accomplished at practically no investment.

At least two manufacturers—Fairchild and Cessna—have prepared pamphlets listing the essential changes and are cooperating in every possible way with purchasers to facilitate licensing. Cessna, for example, in addition to listing the changes necessary, has prepared conversion kits, with parts essential to certification.

The Components & Parts Section, whose stock runs from complete airplane center sections down to cotter pins, is working to channel its surplus back through the original producers and distributors, or producers and distributors of like articles.

This system is being followed for two basic reasons. First, a complete, nation-wide distribution system is immediately available, and, second, it is felt that channeling the materials through these sources will have the least disruptive effect on the nation's economy. By routing this surplus material back through the original channels, it is believed, much of it can be used to take the place of new production, this capacity then being devoted to other military or civilian production.

Since it is impossible at present to get a well-rounded stock from surplus there is an inevitable unbalance—a plethora of some items, a scarcity of others. One type of aircraft, for instance, in the hands of inexperienced students has a tendency to ground loop to the right, with the result that the supply of right wings will probably never be exhausted, but the supply of left panels, on the other hand, may soon be depleted.

At the present surplus parts and components are going to manufacturers on consignment for disposal. On surplus sold to government agencies they receive a commission of 5% and on other sales 10%, plus, in each case, expenses such as for receiving, storing, inspecting, etc. Manufacturers distributing standard hardware items operate on a straight commission basis. This permits a higher total return for energetic sales efforts than it does for less efficient methods.

Manufacturers and distributors are required to hold back at least 20% of their surplus for direct sales to the public.

What may ultimately prove to be one of the most effective disposal units of planes, components, and accessories is the Educational Disposal Section. The law is definite on what can be done, but it is broad enough so that quite a flexible program is being set up. Outstanding feature, at least for recipients, is cost; for under the law only "nominal" prices need be charged for aircraft (which will not be used for flight), parts, and accessories. Thus under the schedule being set up, a school can get a four-engine bomber for $350 or a tachometer for $1—figures designed simply to cover handling and packing costs.

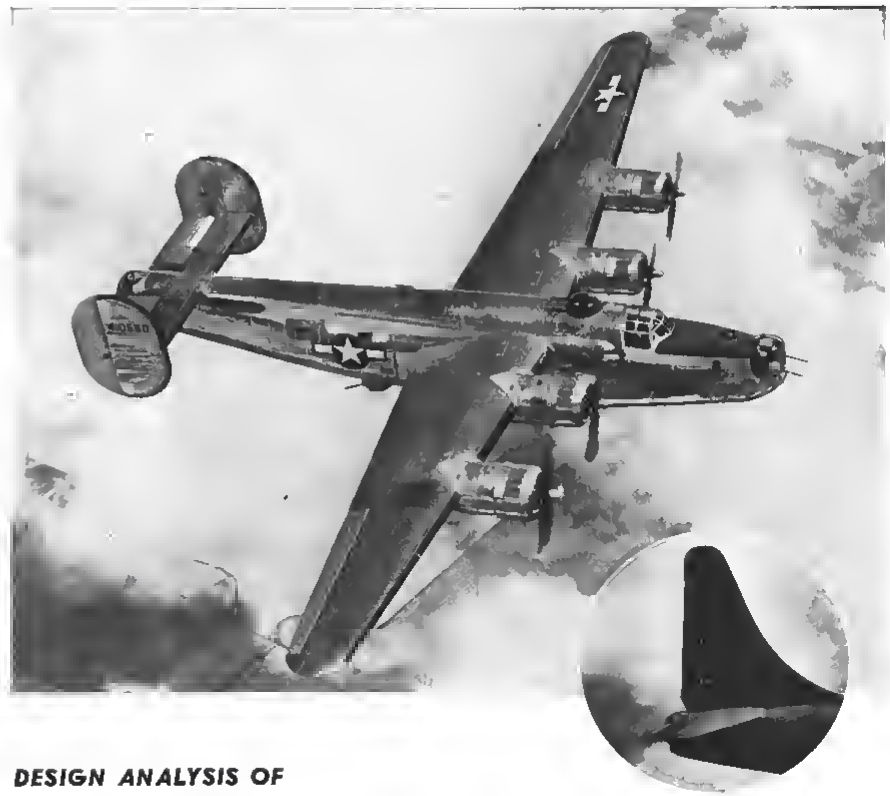
Under the law's definition of educational institutions, the commercial schools operated for profit cannot receive surplus material. There is no chance of such schools getting any unless the law is changed to include them.

As currently arranged, the program is starting with distribution, to some 30,000 schools throughout the country, of a catalog listing surplus items available. Listed are shipping weights by which the schools can determine what their final costs will be. At least until the end of the Jap war it is expected that shipments to schools will be made directly from AAF installations, even though the requests for the surplus are made directly to disposal headquarters in Washington.

SALES CENTERS—AIRCRAFT

Surplus War Aircraft Division
(As of Mar. 22, 1945)

Operator	*Airport*	*Location*	*Loan Agency*
Albany Aircraft Co.	Albany	Albany, N. Y.	New York
Jennings Bros. Air Service	North Grafton	N. Grafton, Mass.	Boston
Thor Solberg	Solberg-Hunterton	Readington, N. J.	New York
Cannon Aeft. Sales & Ser.	Cannon	Charlotte, N. C.	Charlotte
Robert Stamp Flying Ser.	Ford-Lansing	Lansing, Ill.	Chicago
Brayton Flying Ser.	Municipal	Robertson, Mo.	St. Louis
Central Aviation Corp.	Municipal	Omaha, Neb.	Omaha
Des Moines Flying Ser.	Municipal	Des Moines, Iowa	Chicago
Harte Flying Ser.	Municipal	Wichita, Kan.	Kansas City
Thompson Flying Ser.	Municipal No. 1	Salt Lake City, Utah	Salt Lake City
Clarence Ludwig	Ludwig-Sky Harbor	St. Petersburg, Fla.	Atlanta
Akron Airways	Municipal	Akron, Ohio	Cleveland
Cincinnati Air Ser.	Lunkin	Cincinnati, Ohio	Cleveland
Hughes Flying Ser.	Capitol City	Lansing, Mich.	Detroit
Lyndah Flying Ser.	Victory	Minneapolis, Minn.	Minneapolis
Aviation Enterprises, Ltd.	Municipal	Houston, Tex.	Houston
Dakota Aviation Co.	Municipal	Huron, S. D.	Minneapolis
Aviation Activities Co.	Sherman	Concord, Calif.	San Francisco
Great Plains Aviation Co.		DuFont, Col.	Denver
Morrison Flying Ser.	Municipal	Helena, Mont.	Portland
Cutter-Carr Flying Ser.	West Mesa	Albuquerque, N. M.	Denver
Ashburn Flying Ser.	Hybla Valley	Alexandria, Va.	Richmond
A. C. Booker	Bellis	Pittsburgh, Pa.	Cleveland
Western Skyways Ser.	Portland-Troutdale	Troutdale, Ore.	Portland
Reno Sky Ranch, Inc.	Reno Sky Ranch Apt.	Reno, Nev.	San Francisco
City of Morgantown	Municipal	Morgantown, W. Va.	Richmond



DESIGN ANALYSIS OF

CONSOLIDATED B-24 LIBERATOR

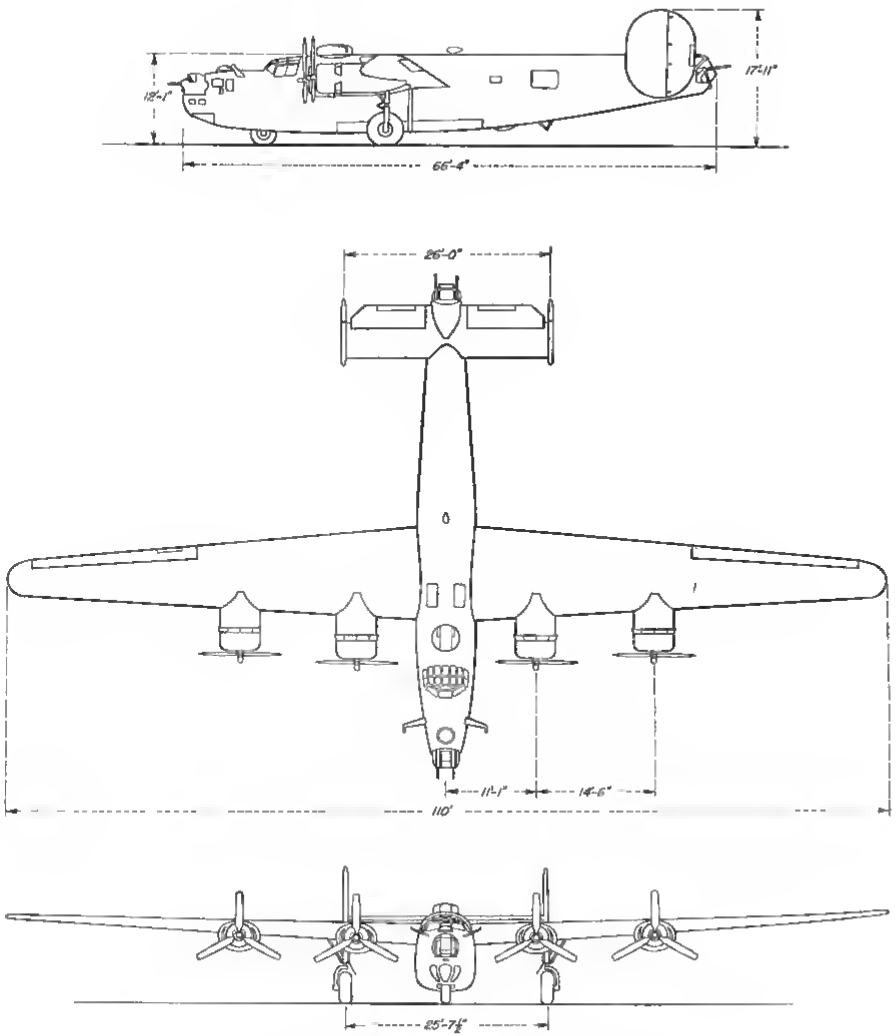
By J. H. FAMME, *Chief Design Engineer, San Diego Div., Consolidated Vultee Aircraft Corp.*

Here's the detailed structural makeup behind the reputation of the "Lib"—famed "heavy", distinguished for its bomb load, speed, and range . . . The 13th of AVIATION'S comprehensive design series.

Since the long range, heavy bombardment airplane was an accepted type and the backbone of AAF flying equipment, it was logical that in 1939, when Consolidated was asked to design a four-engine bomber, the specifications called for greater bomb load capacity, greater speed and greater range. Our answer was the B-24 Liberator design.

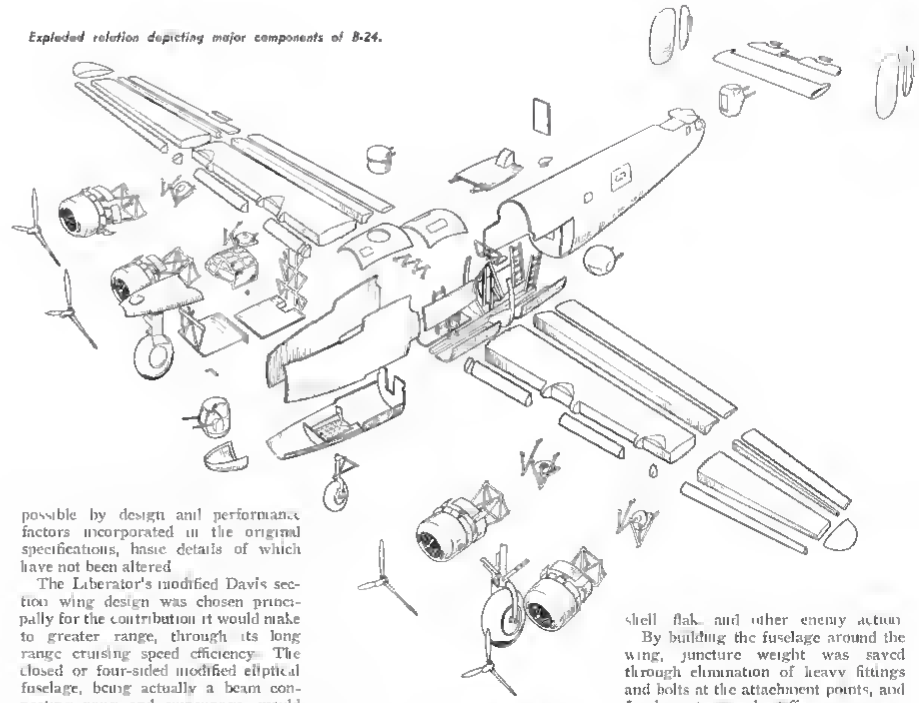
The B-24 is in no way a radical departure from accepted design practice. Instead, it is a particularly successful combination of best features of a number of fundamentally sound airplanes which preceded it on the drawing boards and production lines of the company. It is a four engine, midwing monoplane with—until recently—a twin rudder tail assembly. This has now been replaced for the AAF by a single vertical fin dorsal assembly—similar to that on the Navy Privateer PB4Y-2 which has been in production for over a year.

Although the Liberator was designed as a bomber, there have been more than 100 modifications and conversions—some 78 of which are in daily use. Other routine assignments include photographic, cargo, passenger, and route-exploration missions. Among its more recent modifications is a flying tanker conversion for ferrying gasoline. And all modifications were made



Three-view aspect of B-24 Liberator showing major dimensions

Exploded relation depicting major components of B-24.



possible by design and performance factors incorporated in the original specifications, basic details of which have not been altered.

The Liberator's modified Davis section wing design was chosen principally for the contribution it would make to greater range, through its long range cruising speed efficiency. The closed or four-sided modified elliptical fuselage, being actually a beam connecting wing and empennage, would be a deeper, stronger structure providing greatest space for bomb bays, crew quarters, armament, and operational equipment.

Fuselage

The fuselage is a semi-monocoque shell consisting of smooth skin reinforced with Z-type 24ST Alclad rolled stiffeners or stringers and transverse bulkheads and belt frames. The longitudinal stringers are generally spaced at about 6 in. intervals, with greater concentrations where required for added strength. Longerons are used only to carry loads around openings at bomb bays, access doors, and other points where the skin-stringer combination is broken.

Belt frames, to maintain fuselage shape are .040 24ST Alclad flipped channel, notched to pass over stringers and spaced about 1½ ft. apart.

In the bomb bays, where belt frames and longitudinal stringers are interrupted, in the lower half of the fuselage, vertical stiffeners are spaced about 7 in. apart to avoid passing stringers around or over bomb bay door tracks. Side longerons are channel shape, 5 in. wide and 2 in. deep at their widest part in the bomb bays, tapering out 6 to 8 ft. in both ways.

Skin-stringer-bulkhead-belt frame structural design was used because strength is dispersed rather than concentrated in a few critical members, a distinct advantage in any assembly subject to combat damage—bullet, rocket shell flak and other enemy action.

By building the fuselage around the wing, juncture weight was saved through elimination of heavy fittings and bolts at the attachment points, and fuselage torsional stiffness was improved. This method joins the wing and fuselage by means of a continuous, riveted and bolted attachment around the periphery of the box structure of the wing formed by the upper and lower surfaces and the front and rear spars.

At the ends of the bomb bays are bulkheads connected longitudinally to a partial bulkhead in the center between the two bays by a beam which also forms the catwalk. Aft end bulkhead is a plate girder type built up of rolled sections and flat sheet. Upper part of the front bulkhead is a truss; the lower portion is flat sheet. The partial bulkhead between the two bays extends upward only to the wing to provide lateral support for the catwalk.

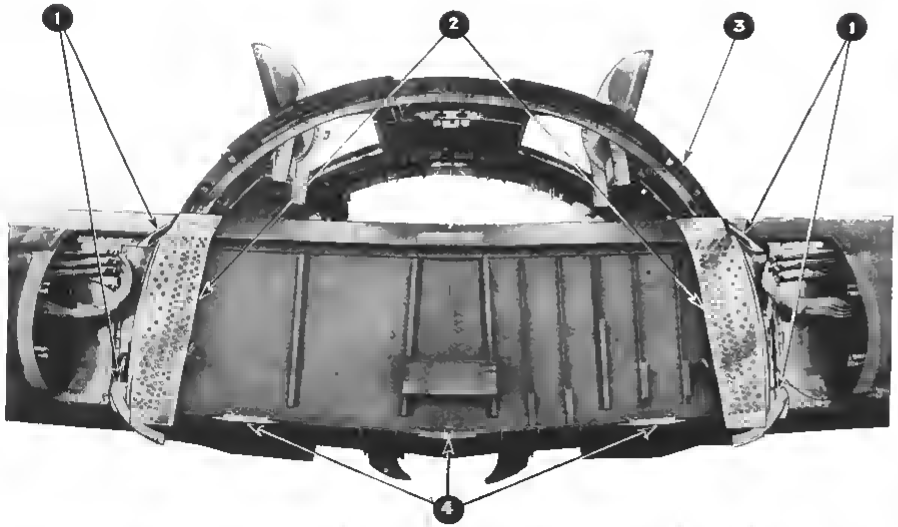
The catwalk through the bomb bays serves as a longeron and provides for transverse and longitudinal loads from the bomb racks. It consists of two U-shaped channels forming the sides, a corrugated Alclad top serving for the walk, and a smooth Alclad bottom forming part of the outside skin of the fuselage. Diaphragms of pressed sheet spaced about 2 ft. apart maintain the cross-section of the catwalk. The cat-

Liberator Wing Data

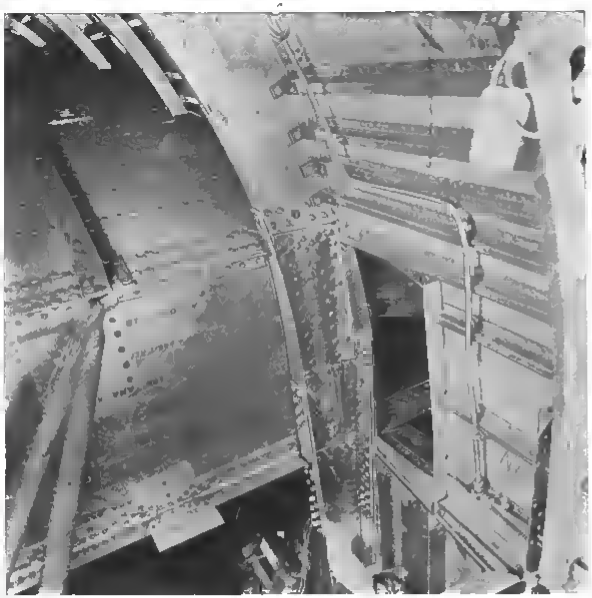
Airfoil section designation	
Root	CVAC 22%
Tip	CVAC 9 3%
Wing area	1,048 sq. ft.
Span	110 ft.
Root chord	14 ft.
Tip chord	5 ft. 2-13/32 in.
Thickness at root	22%
Thickness at tip	9 3%
Incidence	3 deg.
Dihedral on upper 30% chord line	
	1 deg. 30 min.
Sweepback (L.E.)	3 deg. 30 min.
Trailing edge sweep forward	
	5 deg. 38 min.
Twist	None
Spar location, front	10% chord
Spar location, rear	66.2% chord
Aspect ratio	11.5
Mean aerodynamic chord length	123.72 in.
Location relative to L.E.	
L.W. (chord—horizontal)	17.04 in. aft
Root chord—vertical	16.6 in. above

Fuselage Dimensions

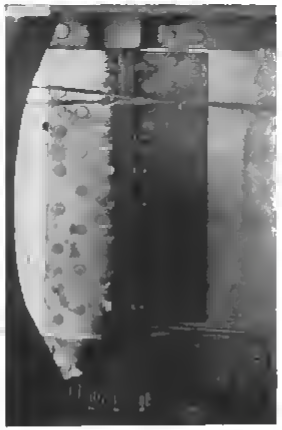
Length	66 ft. 4 in.
Maximum height	18 ft. 5 in.
Maximum width	7 ft. 6 in.



Details of fuselage attachments on wing center section, front spar, (1) Wing to fuselage attachment angles (2) channels, (3) fuselage fairing (wing oval compartment) riveted to wing upper surface, and (4) wing-to-fuselage attachment fittings.

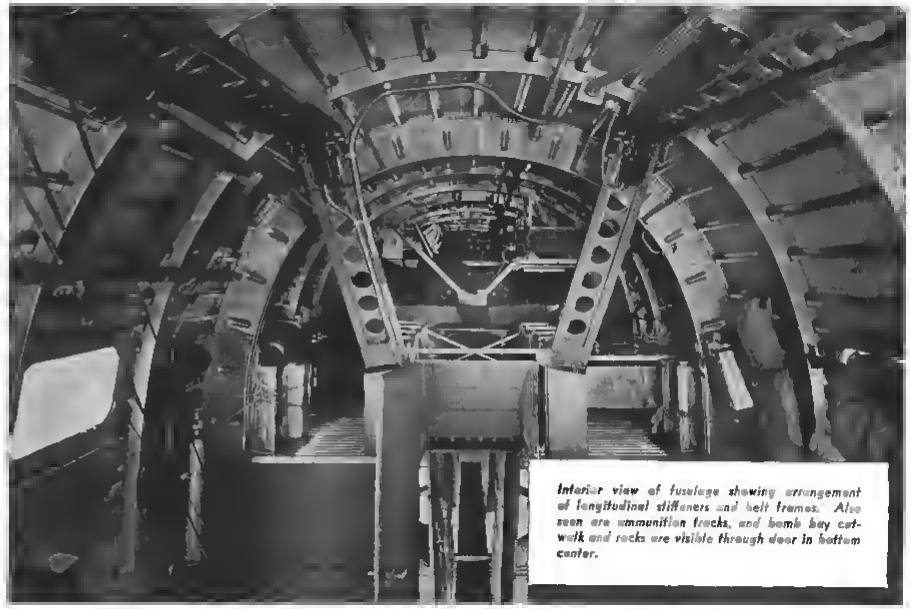


Fuselage-to-wing splice from rear spar side illustrating method of joining attachment fittings previously riveted to spar and fuselage, by means of rivets and bolts.

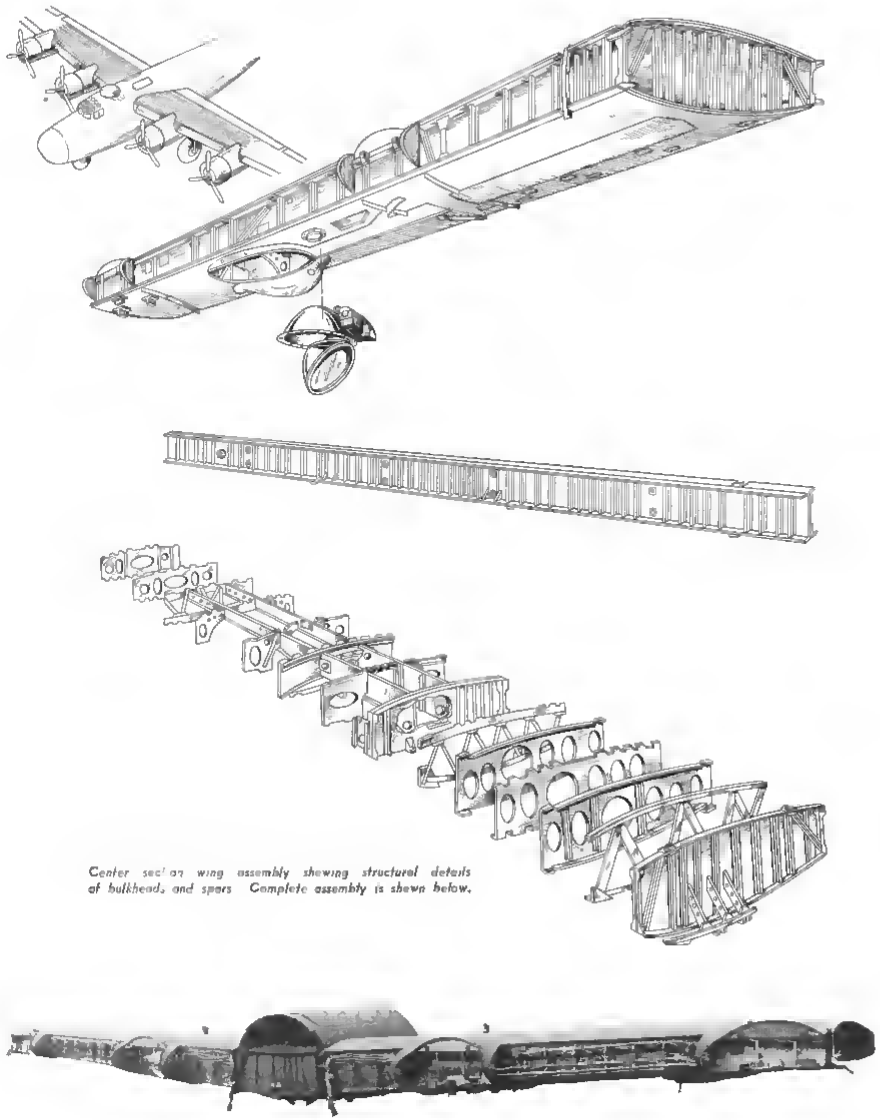


Typical spar splice in Liberator wing.

Structural details of fuselage interior above fuselage-to-wing splice. Life raft cradle is seen at lower center.



Interior view of fuselage showing arrangement of longitudinal stiffeners and belt frames. Also seen are ammunition tracks, and bomb bay catwalk and racks are visible through door in bottom center.

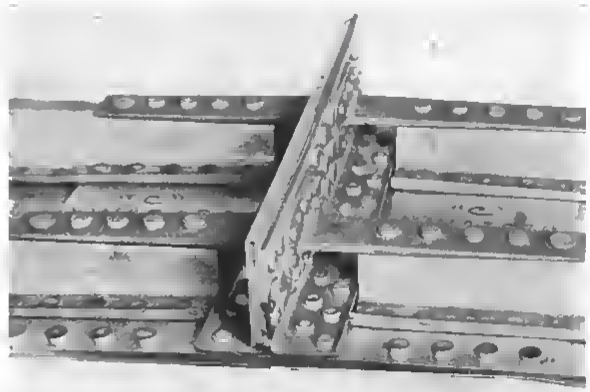


Center section wing assembly showing structural details at bulkheads and spars. Complete assembly is shown below.

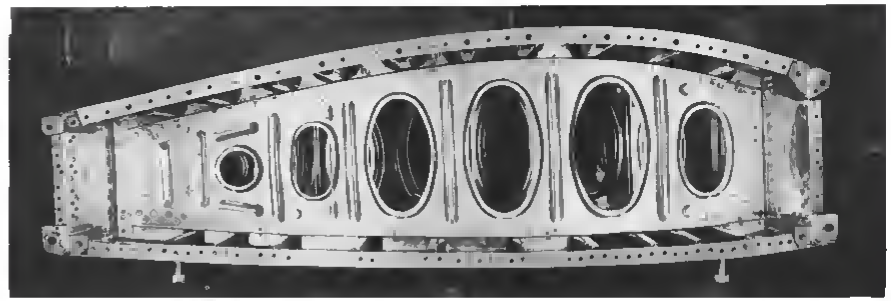
walk ends aft at a curved box beam which transmits loads to two longerons around the ball turret opening. These taper out 4 ft. beyond the turret opening. Forward, the catwalk tapers out ahead of the forward bomb bay. Around the nose wheel well, loads are passed through auxiliary longerons.

Nose wheel gear attaches at four points. Two upper attachments are to the floor truss of radio operator's compartment, the truss passing loads to the fuselage sides. Two lower attachments are to the main bulkhead of pilot's compartment, a plate girder built up of rolled sections and flat sheet, transmitting loads to the fuselage shell.

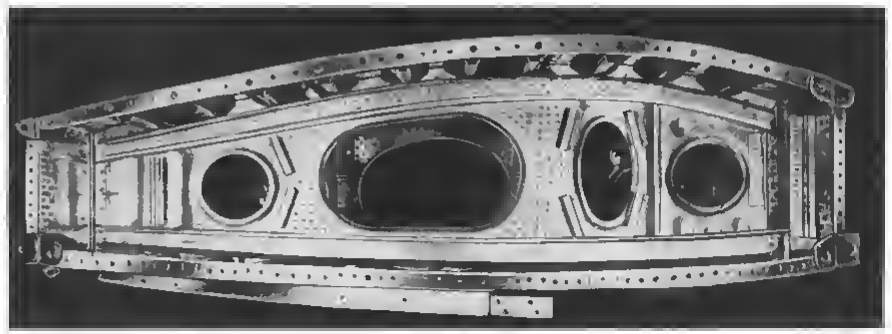
Vertical supports of the rear bomb racks are welded steel tube trusses in turn welded to gusset plates which are riveted to the rear spar of the wing, while forward racks tie to the lower surface of the wing by bolted fittings which pass loads to the wing internal structure. Bomb loads—because of this means of supporting the racks—are

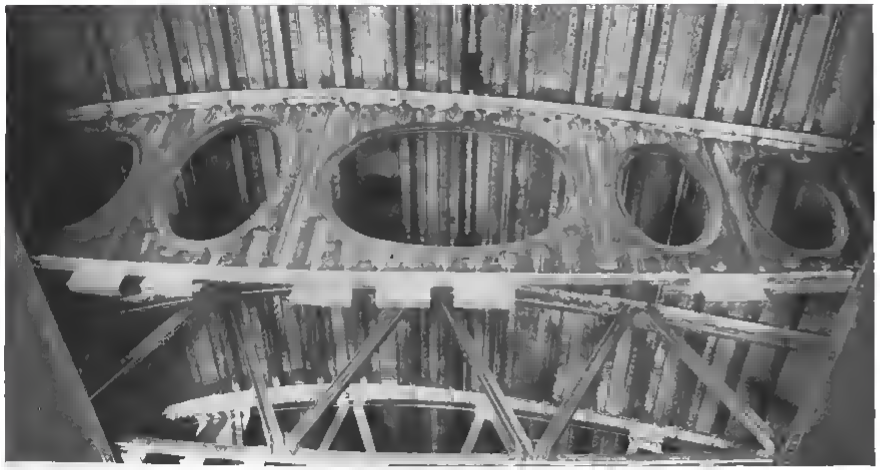


Closeup of typical wing hat section skin splice at bulkheads located 147 in. from centerline and at centerline. Note forged flange strap fittings and splice plate.

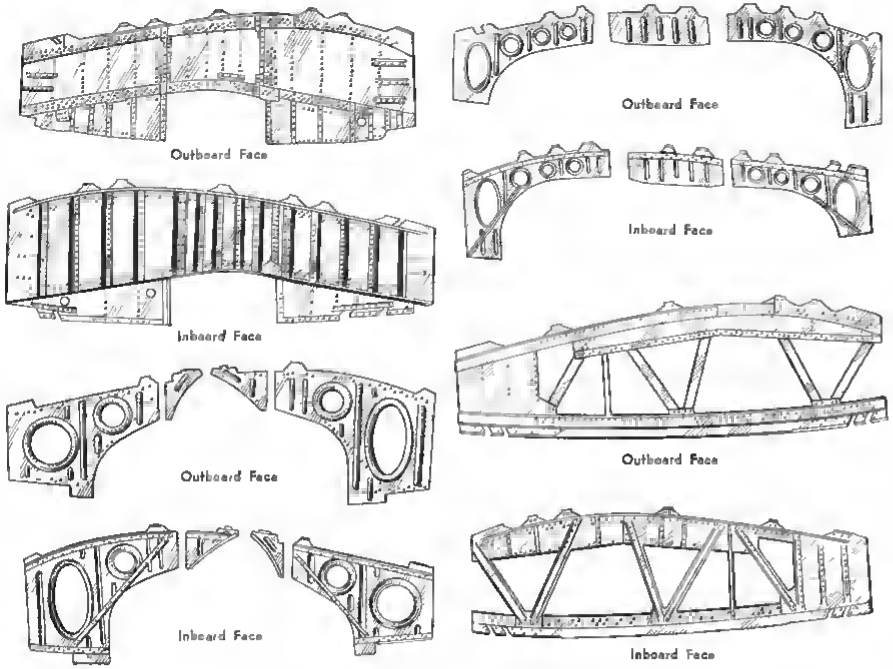


Shown at top is outer wing panel looking outboard at splice. Bolts for channel at left are accessible from outside wing; those for member at right by removal of firewall on front spar, and bolts for top and bottom surfaces are accessible from inside wing. Below is wing center section looking inboard at splice. Channel beneath bottom surface is outboard nacelle fairing attachment.





Wing structure at space for fuel cells. Dot fasteners on bulkheads and ribs are used to attach canvas covers to protect cell from abrasion.



Typical wing center panel bulkheads.

actually carried by the wing, rather than to the wing by means of the fuselage. For load purposes, the wing attaches to the fuselage through bolting and riveting of channel type bulkheads to the front and rear spars of the wing.

Bomb bay doors are flexible and made up of corrugated section, 24ST Alclad, spot-welded and riveted to an outer Alclad skin. To open, they slide up on the outside of the fuselage by means of rollers attached to the ends of the corrugations and running in curved tracks.

Bombardier's compartment is merely a continuation of the fuselage nose section. It is standard monocoque construction of flat sheet supported by stringers and three bulkheads built of formed U-channels of Alclad and 24ST sheet. Ahead of bombardier's position, the fuselage supports a tub-like structure in which the forward turret is mounted. Supporting structure is carried on two short and heavy deep beams of 24ST Alclad, bolted to the foremost fuselage station bulkhead by heavy aluminum alloy forgings.

Pilot's enclosure is approximately midway between front of fuselage and leading edge of wing, and is faired into main portion of the fuselage.

The flight deck, immediately aft of pilot's position, has a floor slightly lower than pilot's floor. It carries drag loads from the main landing gear back to the wing and also supports radio equipment and radio operator.

Emergency exits are provided in the top of the fuselage above the bombardier and pilot positions, and in the bottom of the fuselage aft of the waist gun compartment for tail and waist gunners. Bombardier may also leave by way of the nose wheel door, and pilots and upper gunner may leave through the forward bomb bay. Waist and tail gunners can also use the waist gun windows.

Wing

Design of the B-24 wing was based on a geometrically similar airfoil used with considerable success on Consolidated Vultee Model 31 flying boat. Ease of production was one of the main considerations in selecting this wing design.

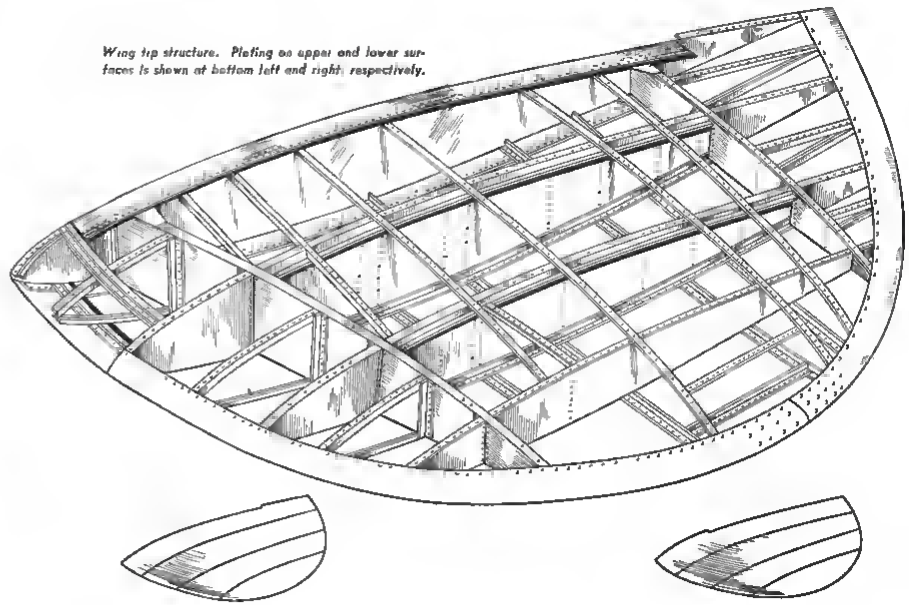
The wing envelope is established by connecting corresponding percentage ordinates of the construction root and construction tip sections. Construction tip and root sections are normal to a chord plane. Each left and right chord plane is set at an angle of 3 deg. 26 min. to the horizontal, and the chord section on the plane of symmetry is established by intersections of the percentage point connecting lines. The tip is faired from the construction envelope in conventional manner.

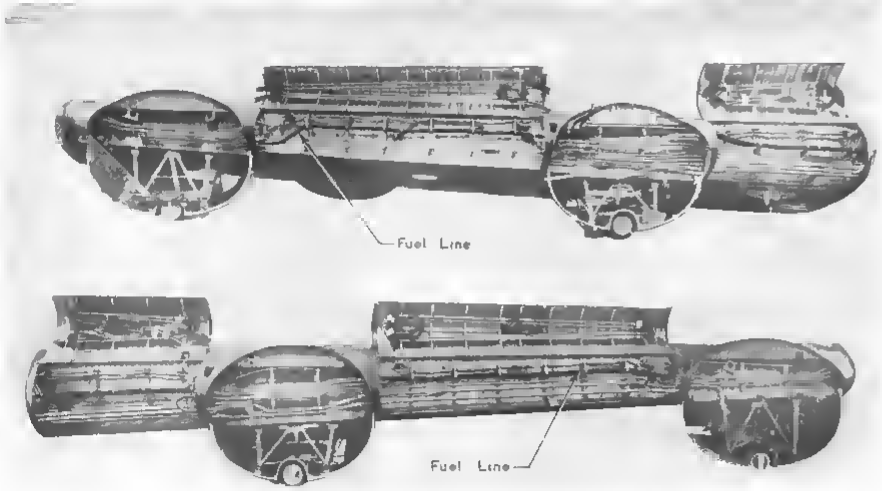
A center section and two outer panels comprise the main units of the wing and are mated by flush, tension-bolted splices. The spar locations were widely spaced to provide maximum room for fuel cells of sufficient capacity to insure the greater range specified by the AAF, and also to provide clearance for main landing gear wheels.

The center section has a span of 55 ft., and its structure includes two auxiliary spars of plate girder type, built up of heavy, rolled angles and flat sheet riveted to two of the main wing bulkheads to support the landing gear. Both main and auxiliary spars are Wagner type with Z-section vertical stiffeners spaced 4–6 in. apart, and rolled angle flanges. To eliminate joggles, the flanges are placed back-to-back on the web against the face of the paired angles. Stiffeners are placed on the web surface opposite the flanges, so that the components can be easily fitted together without appreciable loss of structural efficiency.

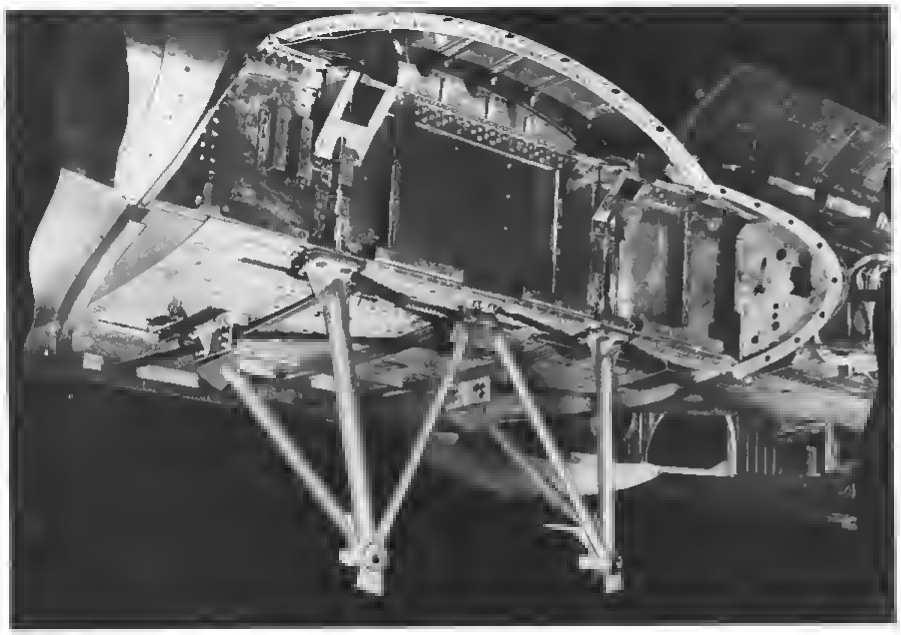
Bending loads are carried primarily by the upper and lower surface plate-

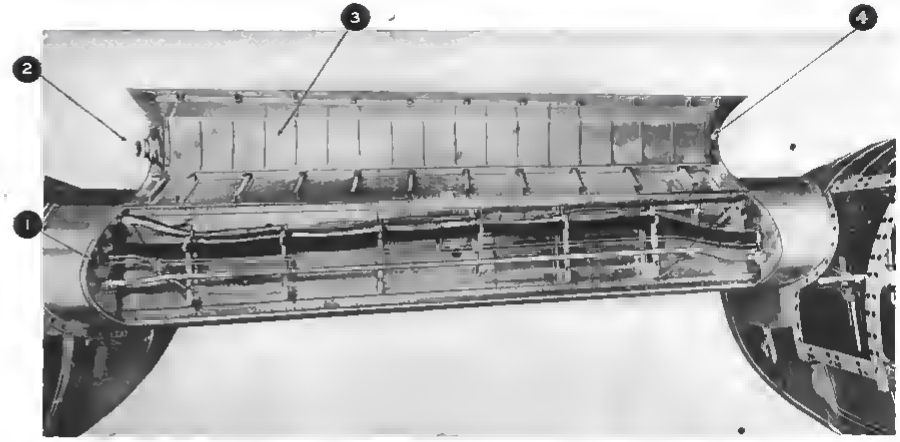
Wing tip structure. Plating on upper and lower surfaces is shown at bottom left and right, respectively.



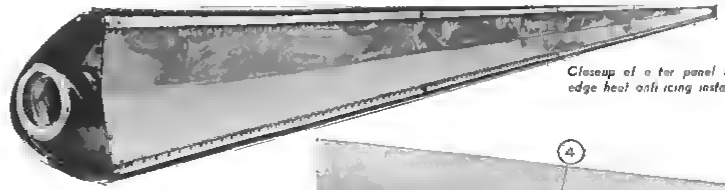


Above. Leading edge of right and left halves of wing center structure with hinged cover is raised to expose plumbing. Four points of attachment for each engine are shown, two on front spar, two on after-mount projecting downward from wing lower surface. Details of outboard nacelle after-mount and upper attachment point are seen below.





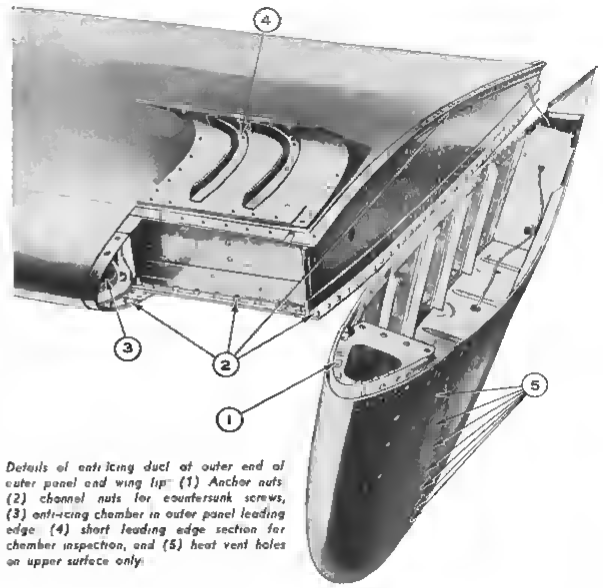
Wing leading edge showing hinged panel containing anti-icing duct. Connection (1) attaches to flange (2) fitted with asbestos cloth flexible coupling, and anti-icing duct (3) is closed at side (4).



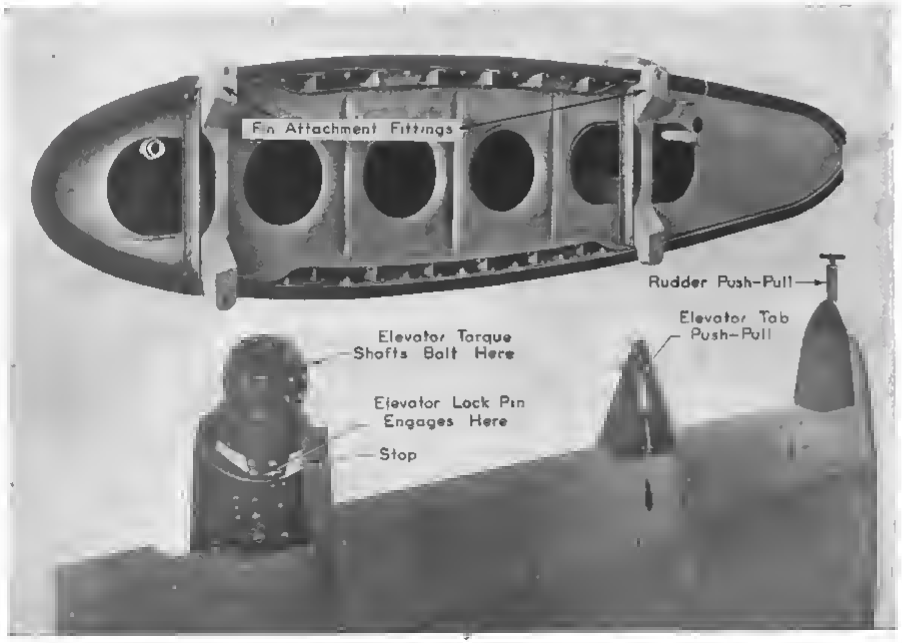
Closeup of outer panel leading edge heat anti-icing installation.

stringer combinations. There are 5 upper surface skin sections or panels on each side of the centerline. The upper skin at the root is .125 24ST Alclad for the forward 60 percent of the interspar distance, and .091 24ST Alclad for the aft 40 percent of the interspar distance. These skins extend spanwise 147 in.—to the end of the main fuel cell region. The remaining skins on the upper surface of the center section are divided into 3 strips. The forward strip is .114, the center strip .102, and the aft strip is .091 24ST Alclad. The gage reductions are made to save weight when strength requirements are reduced.

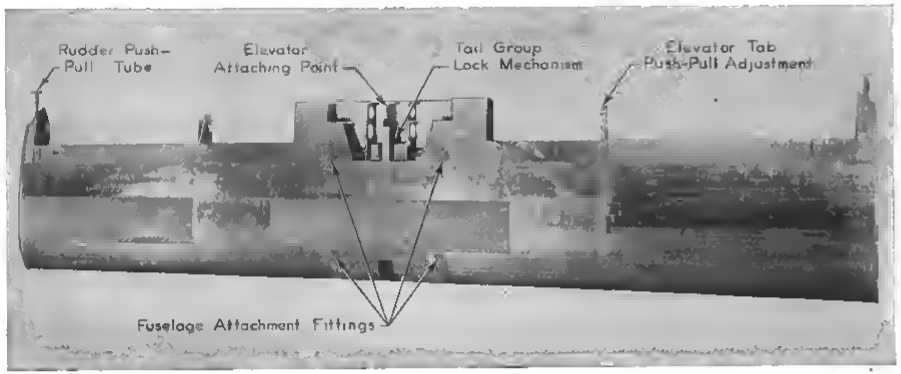
Rolled hat-section stringers of approximately similar gages are used for skin stiffening. Skin and hat splices occur at the bulkheads 147 in. from the centerline, and also at the centerline. Forged flanged strap fittings and splice plates connect both hat sections and skins. Outboard splice plates are buried, causing the splices to be flush. At the outer panel-to-center section



Details of anti-icing duct at outer end of outer panel and wing tip: (1) Anchor nuts, (2) channel nuts for countersunk screws, (3) anti-icing chamber in outer panel leading edge, (4) short leading edge section for chamber inspection, and (5) heat vent holes on upper surface only.



Closeup above shows details of horizontal stabilizer depicted below. Carrying entire load of tail group, four aluminum alloy forgings riveted to stabilizer spars, are used for attachment to similar fittings on fuselage. Eight bolts are used in stabilizer-fuselage connection.



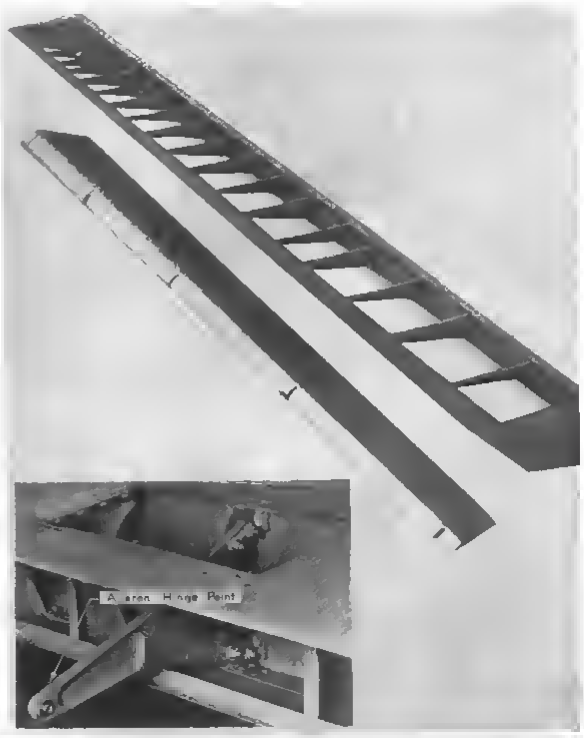
splice the hat sections are connected to an inverted flange splice angle by U-forgings riveted to the sides of the hats.

The lower surface plating of the center panel is stiffened by 1½ in. drawn Z-sections. The plating and stringers are tapered from even distribution at the splice to bands approximately 10 in. wide at the front and rear spars adjacent to the wheel well. The bands are parallel to the main spars, and the plating becomes continuous at the outboard end of the fuel tank. Material is concentrated by reinforcing sheets which reach a maximum thickness of approximately 9/16 in. at the wheel well. Spar flanges are jog-

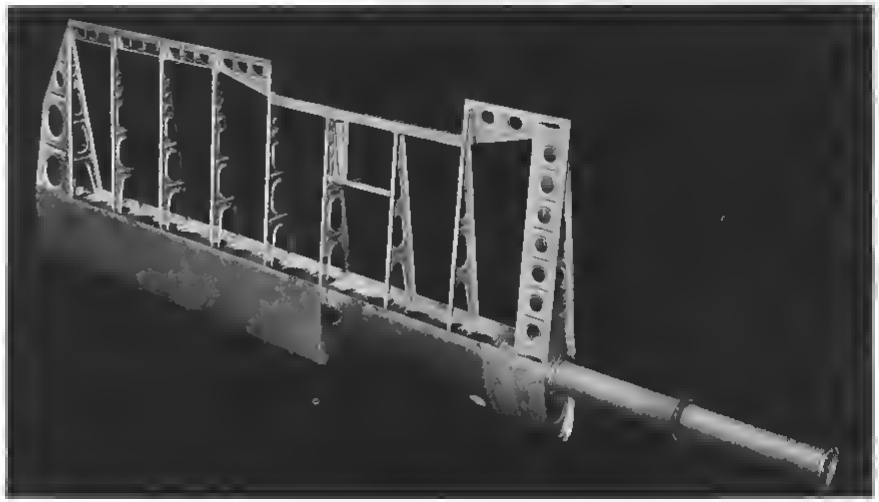
Seen here are structural features of aileron. Assembly has Alclad sheet leading edge and is hinged to wing outer panel at 5 points. Inset shows hinge attachment details.

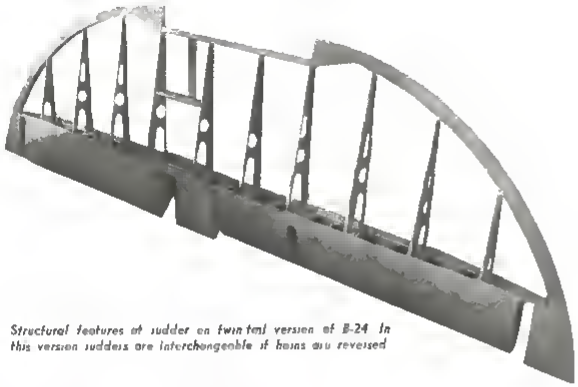
gled to accept the reinforcing sheets, and Z-stringers are spliced by fittings similar to those used for the hats at the main tank bulkheads. Stringers are attached to the wing splice attaching angles by forged T-fittings. Rivets on the upper surface of the interspar area are machine countersunk. When the required diameter is ⅝ in. or less, brazier-head rivets are used on the lower surface, all larger rivets are machine countersunk.

Center section interspar bulkheads are of three types—Wagner beam, truss, and pressed sheet—depending on what loads they carry, type of load, and whether access through them is required. There are 27 of them, 13 on each side and one at the center. The Wagner beam web is flat Alclad sheet and rolled angle flanges set back-to-back with the web on one side and stiffeners on the other. Trusses are Warren type with rolled channel chord members and interconnecting diagonal rolled channels.

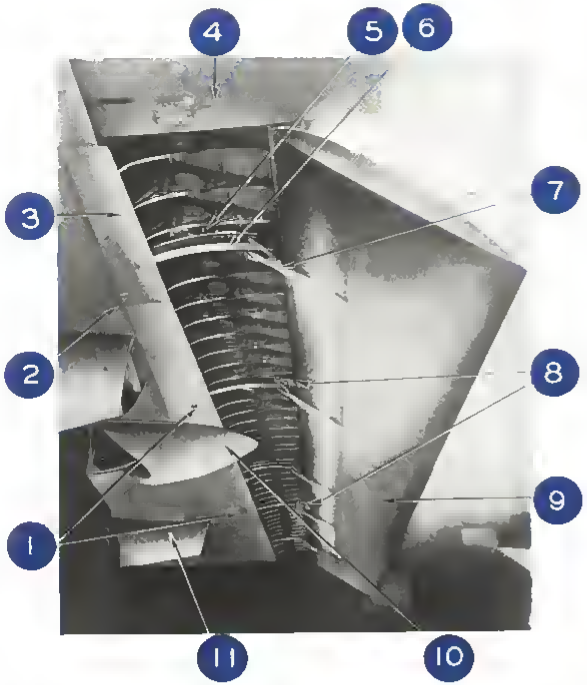


Details of elevator structure. Torque tubes of the two units are bolted together through control lock fitting mounted on stabilizer at centerline of plane. Hinge bearing supports are aluminum alloy forgings bolted to spars, and elevator movement is limited by stops.





Structural features of rudder on twin-tail version of B-24. In this version rudders are interchangeable if hinges are reversed



Fowler flap installation showing (1) Up-stop inspection slots (2) wing splice (3) wing trailing edge (4) aileron (5) flap track support (6) flap track, (7) flap carriage, (8) flap extending cable attachments, (9) flap (10) wheel well fairing, and (11) engine nacelle fairing

Main wing fittings include two hoist fittings which may be used in lifting the entire airplane in the weight-empty condition. They are attached to the bulkhead at the wing centerline.

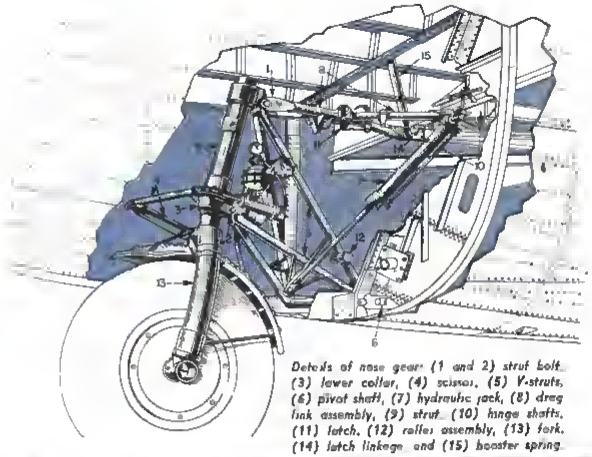
Landing gear fittings are simple forged flanged bosses, riveted to the auxiliary spars, also Wagner type with a web of flat Alclad sheet and rolled angle flanges set back to back, the web on one side and stiffeners on the other.

Upper engine mount fitting forgings are bolted and riveted directly to the upper surface of the front spar, while lower engine mount fittings are carried on a welded tubular sub-structure.

Fuel Tanks

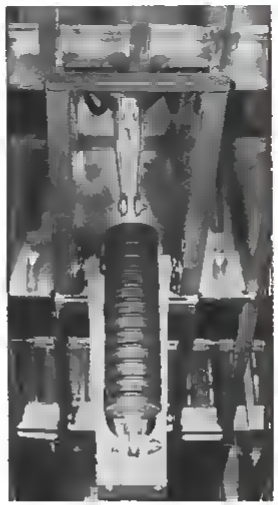
Two integral fuel tanks, each extending 147 in. from the wing centerline, were installed in the first Liberator wing. Sealing was accomplished by placing thin synthetic rubber gaskets in the tank seams. Little trouble was experienced with this type of construction which had been previously developed and proved in the PBY's but military requirements made it necessary to replace the integral fuel tanks with self-sealing cells. Later, auxiliary cells were added in the area outboard from the wheel wells to the first outer panel bulkhead, providing still greater range.

No basic design change was required to effect the fuel tank changes. A larger access door on the underside, removable members in two bulkheads adjacent to the ends of the tank region, and small access doors through which to reach fuel cell manifolds were provided and constituted the only wing changes required. Space for the addi-

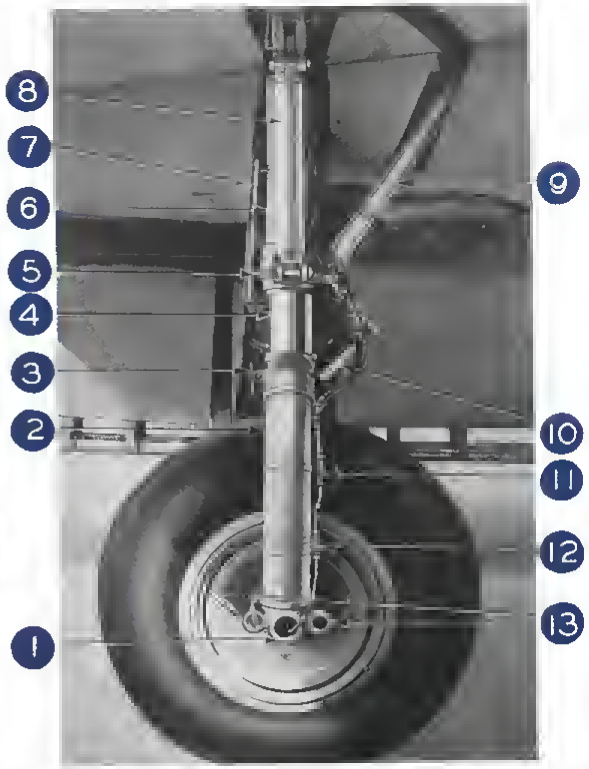


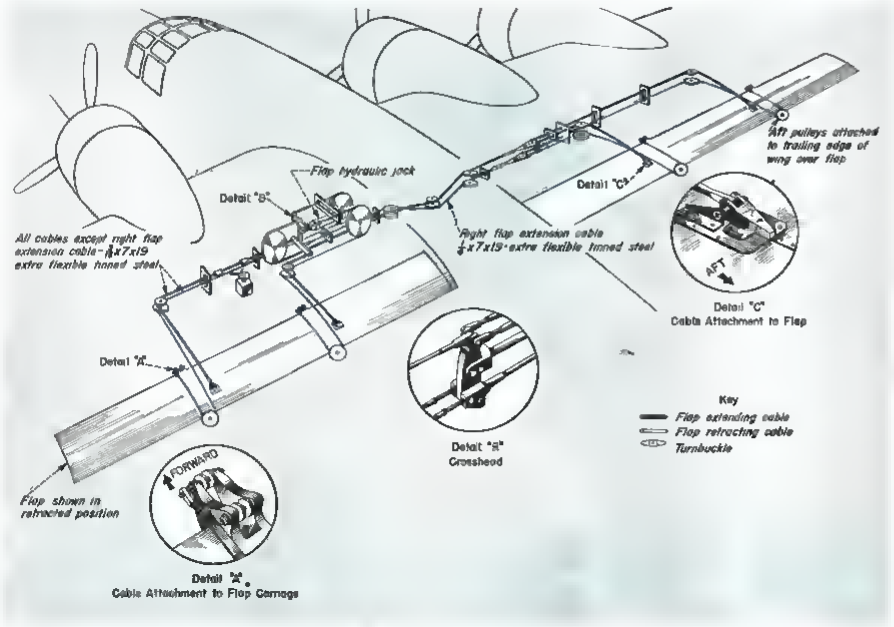
Details of nose gear: (1 and 2) strut bolt, (3) lower collar, (4) scissor, (5) V-struts, (6) pivot shaft, (7) hydraulic jack, (8) drag link assembly, (9) strut, (10) hinge shafts, (11) latch, (12) roller assembly, (13) fork, (14) latch linkage and (15) booster spring

Seen here is retractable tail skid and manner of mounting. Skid is not intended to take full tail landing loads but is designed to withstand rocking load after landing.



Outboard view of main landing gear: (1) Hollow axle, (2) fork tubes, (3) fairing link (4) main oleo piston (5) uplatch roller bolt, (6) oleo main cylinder (7) fairing (8) lower side brace, (9) drag brace (10) scissors, (11) brake lines, (12) bleeder valve and (13) towing lugs. Portion of turbosupercharger installation is seen to right of drag brace.





Details of flap cable installation.

tional tanks existed in the original wing and was merely utilized.

There are 18 self-sealing fuel cells installed in the wing, 9 on each side of the centerline. The 12 inboard cells make up the main fuel cell system, with a capacity of 2,343 gal., and 6 outboard cells comprise the two auxiliary systems with a capacity of 450 gal., giving a wing tank capacity of 2,793 gal. Two additional cells with a combined capacity of 790 gal. can be installed in the forward bomb bay.

The 18 cells comprising the normal or wing system are interconnected by flexible self-sealing manifolds to make six units of three cells each. Main system manifold connections are accessible through access doors in the lower surface of the wing. Auxiliary system manifold connections are reached from the inboard side of inboard nacelles. Main system units of three cells with interconnecting manifolds have a fuel booster pump located under the final cell of the unit, a shut-off selector valve, fuel strainer, and engine driven pump.

Normally, fuel from one main unit is delivered independently to one engine (engine No. 1 from system No. 1). Fuel is transferred from the auxiliary to the main cells by the fuel transfer system. Connection of the auxiliary cells to the engines is through the crossfeed system.

Main fuel cells in the wing center section are held in place by their fit to the compartment. Where the cell does not completely occupy the full fore and aft depth, spacers are installed between the cell and front spar. Canvas curtains snap into place between the sides of the cells and the rib members.

The center section compartment is provided with a drain on each side of the centerline to discharge overboard any fuel which may leak from the cells. Flanges of these drains are located immediately aft of the two inboard booster pumps and are fitted with shut-off valves and overboard discharge lines.

The booster pump gland drains empty into these lines. The drain outlets lead through a bulkhead on each side of the catwalk and extend below the skin. The wing compartment vent lines are located on each side of the centerline of the inboard nacelles and pass through the center of the wing spar and out through the wing lower surface aft of the No. 2 and No. 3 nacelles.

Flap Data

Type	Fowler
Area, total	144.4 sq. ft.
Movement	0 to 40 deg. down

Aileron Data

Area (aft of hinge)	64.4 sq. ft.
Angular movement	20 deg. up, 20 deg. down
Differential motion	None
Distance from plane of symmetry to centroid of aileron area	40 ft. (approx.)
Balance	Aerodynamic
Tab area	3.64 sq. ft.
Angular tab movement	±10 deg.

Anti-icing System

Leading edges of airfoils were originally designed for boot-type de-icers, but all current models of the airplane feature Convair's new exhaust-heat anti-icing system. This has made it necessary to provide ducts and double skins for conducting heated air to the leading edge surfaces. Edge strips, screwed to a ledge at the spar flange, make it possible to attach the leading edges by means of self-locking nuts in gang channels.

Air heated by exhaust gases is piped through the leading edge and the other parts of the plane—pilots', radio operator's, tail gunner's, and bombardier's compartments, and the upper turret position. Other crew positions rely on electrically heated clothing for protection.

The system consists of a heat exchanger in the exhaust stack just ahead of the turbosupercharger, four in all, through which outside air is passed before flowing through ducts to the wing, empennage, and fuselage compartments. Ducting is aluminum sheet tubing covered with sheet asbestos, and averages 5 in. in diameter.

Each outer panel of the wing comprises an interspar structure with a removable leading edge and wing tip, a trailing edge structure forward of the ailerons, and a trailing edge structure forward of and over the flap. The spars are at 10 and 66.2 percent of the chord, and their design is similar to that of the center section spars. Interspar ribs are pressed aluminum alloy, and plate-stringer combinations complete the bending box.

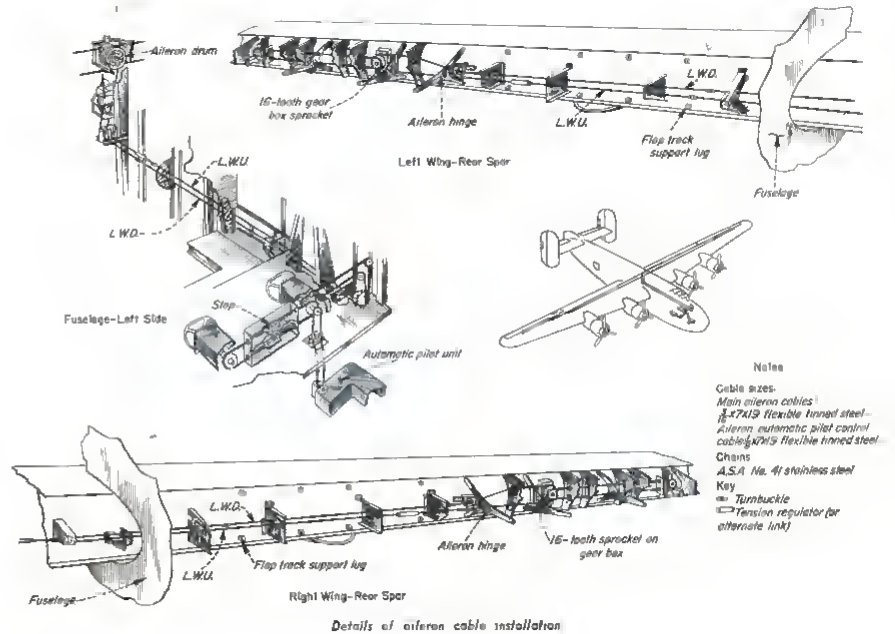
Tail Group

Horizontal Tail Surfaces	
Section	NACA 661-0
Area	192 sq. ft.
Span	26 ft.
Maximum chord	7 ft. 8-3/16 in.
Distance from design gross weight CG (assumed at 25% MAC to 1/3 maximum chord point)	32.40 ft.—approx. 3½ times MAC
Stabilizer	
Area, including elevator balance	140.5 sq. ft.
Normal setting (relative to longitudinal axis)	2.5 deg.
Angular movement	fixed
Elevator	
Area, total	97.1 sq. ft.
Area aft of hinge line	37.5 sq. ft.
Angular movement	30 deg. up, 20 deg. down
Balance	aerodynamic
Tab area	4.05 sq. ft.
Tab angular movement	±10 deg.
Vertical Tail Surfaces	
Section	NACA 661
Fin	
Area, total	123 sq. ft.
Normal setting	0 deg.
Angular movement	fixed
Rudder	
Area, aft of hinge	48.8 sq. ft.
Angular movement	20 deg. R, 20 deg. L
Balance	aerodynamic
Dynamic balance coefficient	0.014 (no greater)
Tab area	3.1 sq. ft.
Tab angular movement	10 deg. R, 10 deg. L

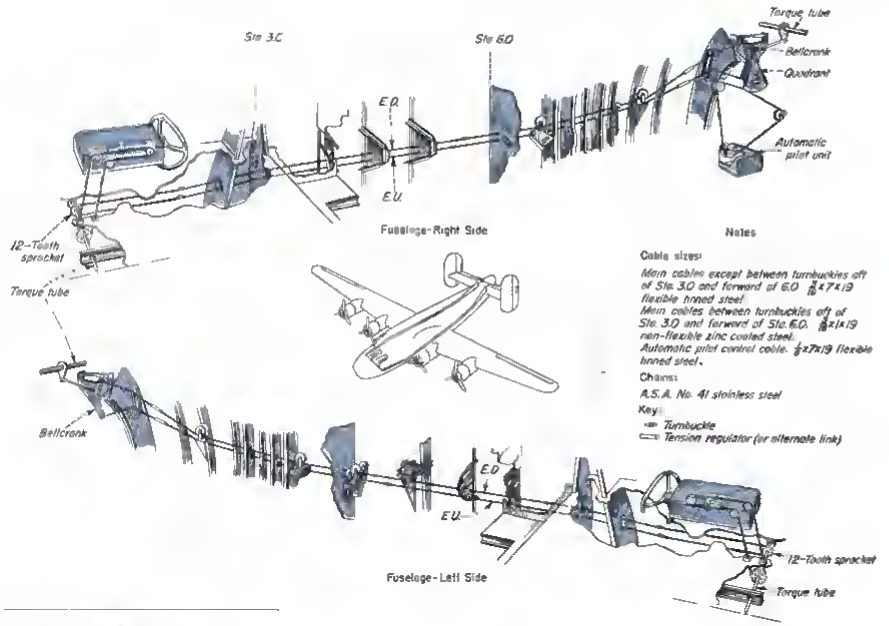
The upper surface employs hat sections at the inboard end, and these splice into 1½ in. Z-stringers which in turn splice down to I-in. stringers and terminate at the base of the wing tip. The lower surface plate-stringer combination is similar, except for the fact that hat sections are not used, 1½ and 1 in. Z's being used for stiffeners. During assembly operations, the wing skins are applied to the upper surface first, front and rear strips are then attached to the lower surface, and the closure is completed by attaching a center strip provided with hand holes. New assembly procedures make it possible to attach plate-stringer surfaces as units.

The ailerons are of typical torque-box pressed rib construction, fabric covered. A two-horn gear box control system was originally used in connection with these surfaces, but this was discontinued in favor of a single-horn push-pull tube bellcrank system. Trimming tabs are provided on both ailerons of latest Liberators.

Most of the rolled sections in the B-24 wing are stretched approximately 3½ percent to the RT condition and, since few extrusions are used, Convair has been able to control section output simply by using sheet stock. Although rolled sections are not as dimensionally accurate as extrusions, little trouble has been experienced in



Details of aileron cable installation



Details of elevator cable installation

Design Weights

	lb
Wing Group	
Center section	4,715
Outer panel	1,178
Tips	39
Ailerons	157
Flaps	252
Total	9,675
Tail Group	
Stabilizer	350
Elevator	136
Fin	210
Rudder	31
Total	830
Fuselage	3,334
Landing Gear	
Main	2,652
Nose	354
Bumper (wheel or skid)	26
Selector valve	3
Total	2,947
Engine Nacelle Group	1,529
Power Plant Group	
Engine (as installed)	8,032
Engine accessories	1,629
Power plant controls	338
Propellers (4)	1,804
Starting system	212
Total	13,243
Lubricating System	
Tanks and protection	385
Piping, etc	325
Total	705
Fuel System	
Tanks and protection	2,248
Piping, etc	280
Total	2,528
Fixed Equipment Group	
Instruments	141
Surface controls	630
Hydraulic system	466
Electrical	1,088
Communicating	335
Armament provisions	3,054
Furnishings	
Personnel accommodations	183
Emergency accommodations	80
Provisions for flight	707
Air conditioning	112
Anti-icing	460
Auxiliary power unit	133
Total	3,131
Standard Weight Empty	38,562

constructing the wings because of flexibility of the fundamental design.

The Fowler flaps have an area of approximately 144 sq ft, and a movement downward of 40 deg. The individual flap is supported by roller carriages, which engage five tracks, four of which are attached to the center section and the fifth attached to the outer panel. Tracks are steel I-beams bolted to a tubular planar truss. Clevises at the forward ends of the tubular truss attach to lugs which protrude through the spar at the spar flanges and attach to bulkhead chord members. Flap controls comprise a cable system actuated by a hydraulic cylinder energized by pressure from the main hydraulic system.

Engine mounts attach to the front spar of the inner section of the wing. Mounts are of welded 4130 c.m. steel tubing. They are of two-bay type, 45½ in. long. Attachment is at four points, by tension bolts, upper two being to the spar and lower two to after-mounts which project downward from the lower surface of the wing because of the thin wing design.

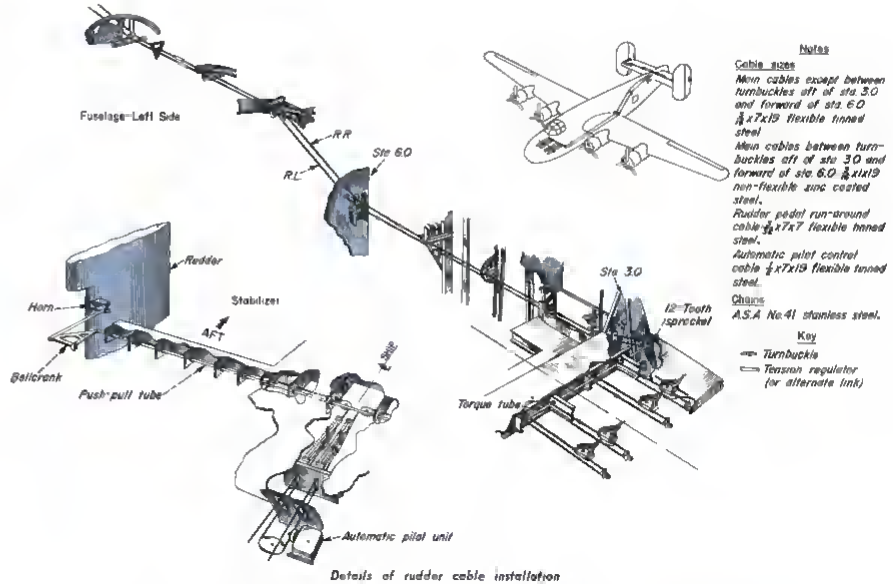
Space in the forward bay, behind the steel firewall, is occupied by an oil tank, and the oil cooler, on the right side, and intercooler on the left side. Aft bay provides space for a turbo-supercharger and its regulator.

The entire assembly—mount, engine, cowling, and accessories—is assembled as a removable unit, which while standardized, is not interchangeable in other than the intended location.

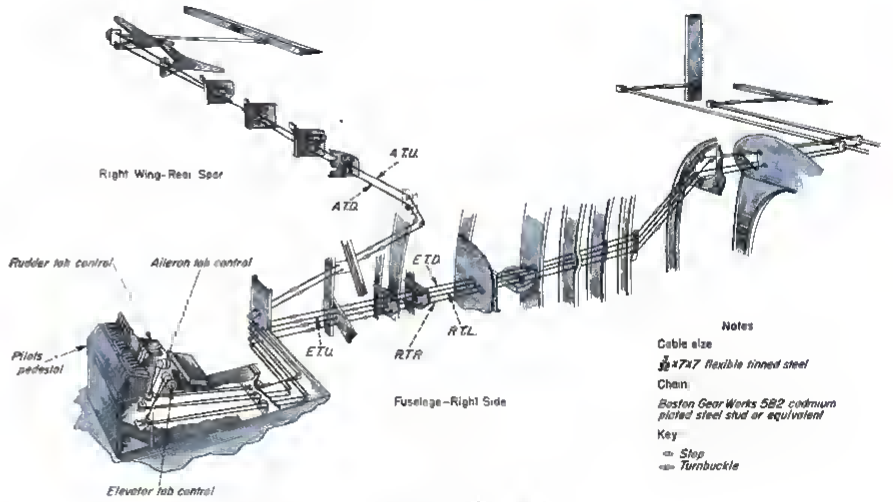
Each engine of the Liberator has its own complete independent oil system consisting of a self-sealing reservoir of 42-gal capacity located within and attached by brackets to the engine mount, a temperature regulator located behind the engine and within the mount, an oil dilution system, and drains, piping, controls, and oil separator.

Power plants are Model C-4, P & W 1,200 hp, each attached by eight flexible shock mounts. Engines Nos. 1 and 2 drive the instrument system vacuum pumps and No. 3 drives the main hydraulic system hydro-pressure pump.

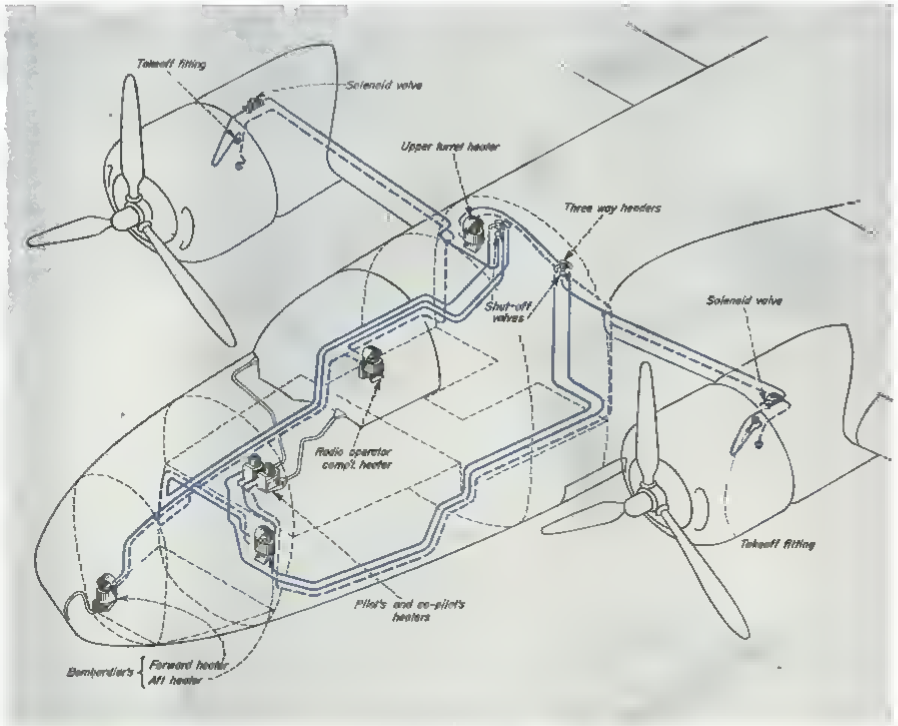
Each power plant is enclosed from the nose ring to the wing by Alclad cowling, except around the exhaust system where stainless steel is used



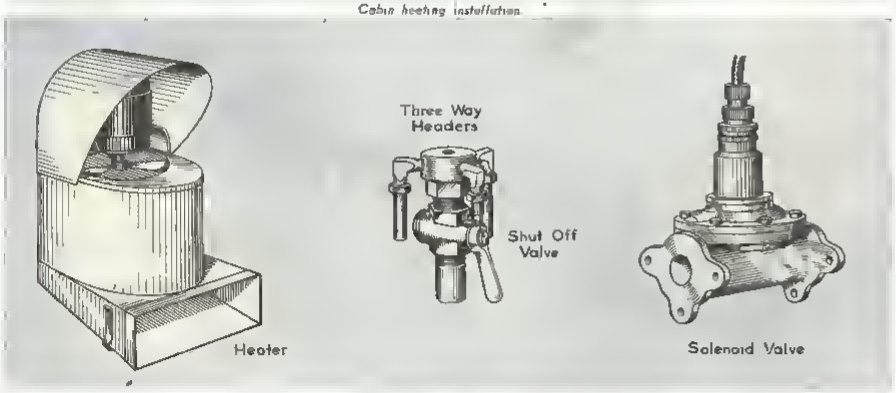
Details of rudder cable installation

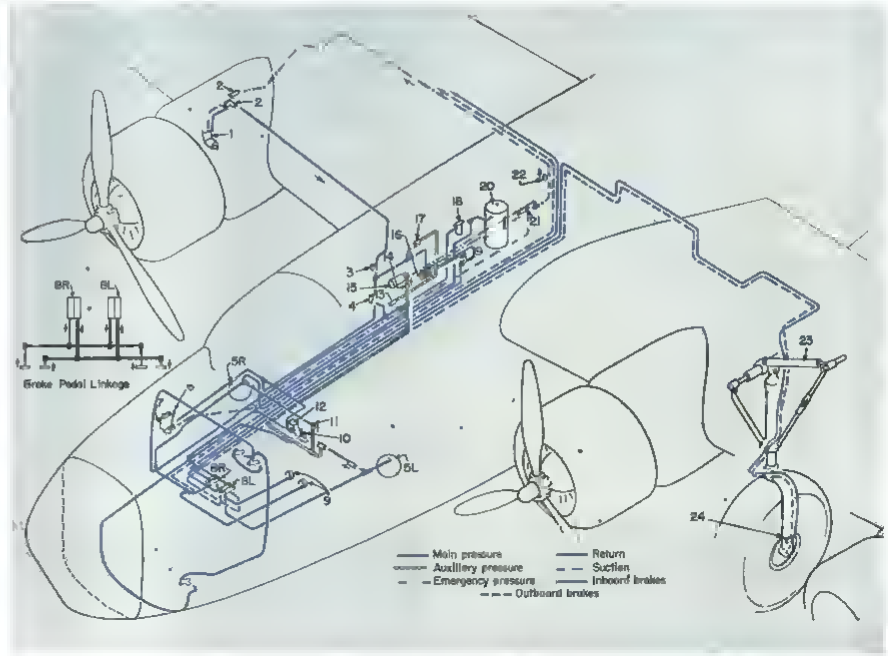


Details of tab cable installation



Cabin heating installation





Brake hydraulic system. Units are: (1) Engine-driven pump (2) automatic seal coupling, (3) engine pump check valve (4) relief valve, (5) accumulator, (6) hand pump (7) flap valves, (8) brake control valve, (9) pressure gage (10) check valve, (11) accumulator check valve (12) unloading valves (13) auxiliary pump relief valve (14) auxiliary pump check valve (15) auxiliary electric pump (16) test stand valves, (17) emergency crossover valve, (18) filter (19) pressure switch, (20) reservoir (21) emergency reservoir valve (22) suction line check valve, (23) landing gear cylinder and (24) brake bleeder valve

The horizontal tail surfaces of the original design (twin rudder assembly) have NACA section No 0015 and contain 192 sq ft Span is 26 ft and maximum chord 7 ft 8⅞ in Distance from the design gross weight C G assumed at 25 percent MAC to the one third maximum chord point is 33 40 in which is approximately 3½ times MAC Stabilizer area, including elevator balance, is 140 5 sq ft Its normal setting relative to the longitudinal axis is 2 5 deg

The elevator has an area of 67 1 sq ft with 51 5 sq ft aft of the hinge line Angular movement is 30 deg up and 20 deg down The elevator is aerodynamically balanced and all spanwise elements are statically balanced about the hinge line Tabs in the trailing edge have an area of 4 95 sq ft and are controlled by an irreversible mechanism

Vertical tail surfaces have NACA section No 0007 with a fin area of 123 sq ft and rudder area of 48 8 sq ft Rudders are aerodynamically balanced and fully balanced statically Spanwise elements are statically balanced about the hinge line Tabs have a total area of 3 1 sq ft, and are equipped with irreversible controls Rudder angular movement is 10 deg right and left of center

The new, single tail assembly, designed at the request of the AAF, required few changes in the original aft fuselage structures The new stabilizer is designed to fit the old type fittings with the dorsal and fin attaching to new structure Front fin spar attaches to a new built-up bulkhead

All tail assembly control surfaces are of aluminum torque box and rib construction, covered with fabric The stabilizer, constructed as a separate assembly, has a smooth sheet metal skin and is attached to the fuselage with only four fittings, to facilitate replacement. The entire tail assembly is mounted just enough forward of the tail gunner's compartment so that the trailing edge does not obscure the gunner's vision

Propellers are Hamilton Standard Hydromatic three-bladed constant speed type, with quick feathering feature Clearances are 37 in to ground and 23½ in to fuselage Normal distance to the plane of each propeller disk is 74¼ in at the centerline of the inboard engine Controls are electrical and convenient to both pilot and co-pilot Feathering pump oil is obtained from the main oil tank

Propeller anti-icing is achieved with two electrically driven pumps installed below a 21 gal tank located above the wing center section, between the life raft doors One pump supplies pressure for both inboard propeller anti-icer rings and the other for the outboard propellers

Anti-icing systems for pilots and bombardier's windshield exteriors are

connected directly to the same tank. De-icing and defrosting of window interiors are by heat exchangers and flexible defroster tubing adjustable for direction against windows.

Landing gear of the B-24 is tricycle type with fore and aft wheel base of 16 ft and a main gear width of 26 ft. 7½ in. In addition to the main gear and nose wheel, a retractable tail skid is provided, which, while not strong enough for full tail landing loads, will withstand the load of rocking after landing. It is supported by an Alclad sheet box structure built into the lower aft end of the fuselage, below the aft gun position, and is extended and retracted hydraulically.

Main gear wheels are Air Corps Type 111, made of aluminum alloy or magnesium alloy castings, requiring 56 in. x 16-ply tires. Nose wheel is fitted with 36 in. x 10 ply tire.

Hydro-pneumatic struts are used on the main and nose gears, with main gear retracting outward and upward into wells in the undersurface of the center wings, and the nose wheel retracting upward and slightly aft into a well just forward of pilot's cockpit floor. The nose wheel is held in the up position by a latch, and the door closing the opening is actuated by the gear mechanism.

Main gear assembly is supported from two false or auxiliary spars located just outboard of the inboard engine cowling, between the front and rear spars. They are plate girder type of heavy rolled angles and flat sheet riveted to two of the main wing bulkheads. Both gears are equipped with emergency release and retraction mechanisms. Brakes are duplex expander tube type.

Being primarily a bombardment airplane, the B-24, however, was required to have armament for defensive as well as offensive action. For offensive action it can carry 4 to 22 bombs in its two bays, and additional bombs in external racks attached to the under surface of the inboard wings.

Latest versions of the Liberator carry an average of ten 50-cal guns aimed and fired from side openings in pairs in 4 power operated turrets situ-

Performance at 56 000 lb. Gross Weight

High speed, 25 000 ft., military power	over 294 mph
Operating speed, 25 000 ft.	over 230 mph
Tactical radius of action, normal mission	750 mi
Service ceiling	35 000 ft.
Takeoff run to clear 50 ft.	under 3 000 ft.
Stalling speed	78 mph

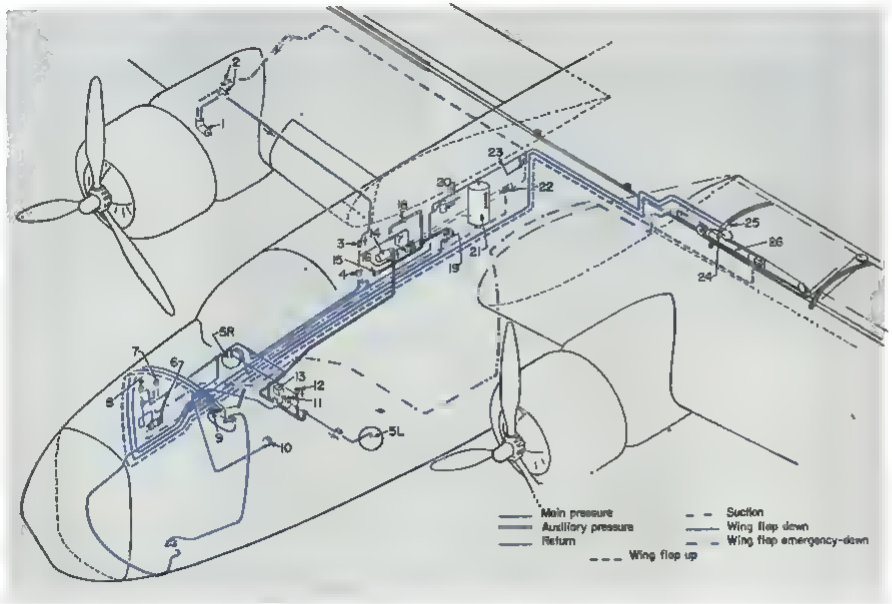
Balance Factors

Alternate gross weight CG location with wheels up, aft of leading edge	30.0% MAC
Most forward for adequate control landing power off	23% MAC
Most aft for satisfactory longitudional stability with power and for satisfactory ground handling	34% MAC

Useful Load

	lb
Crew (nine men)	2 000
Engine fuel (2 120 gal.)	13 718
Engine oil (128 gal.)	960
Guns and accessories	1,053
Bombs	2,007
Total useful load	over 19 738
Weight empty	approx 36 062
Gross weight	over 56 000

Wing flap hydraulic system: (1) Engine-driven pump, (2) automatic seal coupling, (3) engine pump check valve, (4) relief valve, (5) accumulator, (6) hand pump, (7) emergency flap valve, (8) emergency pump valve, (9) flap selector valve, (10) pressure gage, (11) check valve, (12) accumulator check valve, (13) unloading valve, (14) auxiliary electric pump, (15) auxiliary pump relief valve, (16) auxiliary pump check valve, (17) test stand valve, (18) emergency cross-over valve, (19) pressure switch, (20) filter, (21) reservoir, (22) emergency reservoir valve, (23) suction line check valve, (24) shuttle valve, (25) flap relief valve, and (26) flap cylinder.



ated in the nose, the top, belly, and tail. Remaining 2 guns are flexibly mounted, so that they can be manually aimed and fired from side waist enclosure in aft part of fuselage. Armor plate protects areas around all crew members and vital equipment.

Main hydraulic system of the Liberator operates the wing flaps, bomb bay doors, wheel brakes, and landing gear. Rear gunner's turret is hydraulically powered by a separate system mounted on the right side of the fuselage adjacent to the tail turret. The system is a combination of the better features of the direct pressure and open center systems, and is termed an open center pressure and return unit.

The B-24 electrical system has three main sources of energy—batteries, generators, and a 2 kw. auxiliary power unit located on the left side of the fuselage just ahead of the bomb bay and below the flight deck. The units connect to a common distribution system which covers the entire plane. The d.c. to a.c. inverters supply energy to special equipment requiring alternating current.

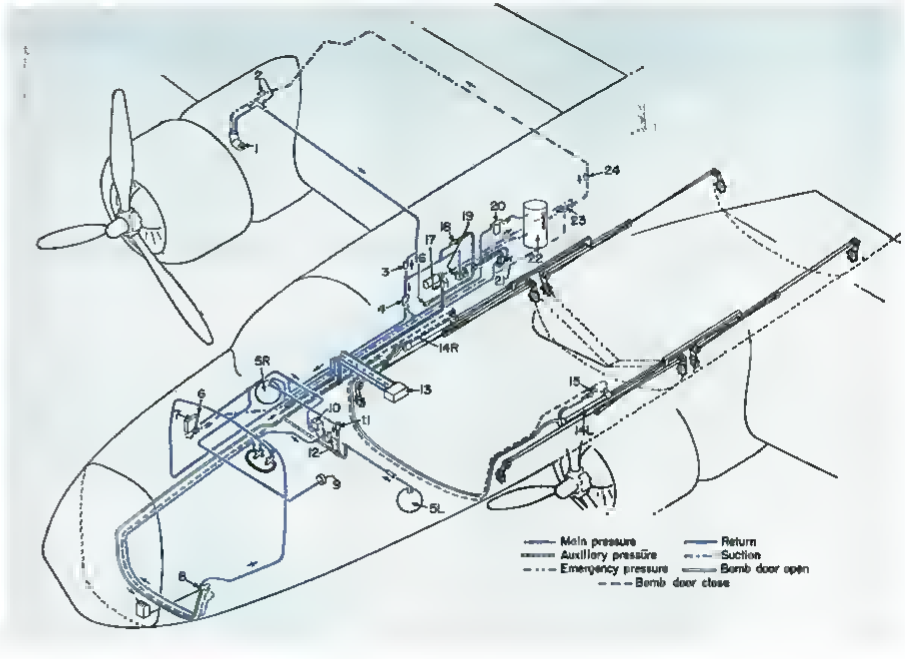
Radio, interphone, and directional radio equipment aboard the B-24 derive power from the 24 v. d.c. supply of the main power system. The interphone consists of an amplifier, dynamotor, jack box, and one throat microphone and microphone-amplifying equipment for each crew station. Each throat microphone is equipped with switch cord or a push-to-talk switch.

The command radio consisting of two transmitters and three receivers, is mounted above the wing center section just aft of the life rafts. Modulator unit, dynamotor modulator unit, and dynamotor are mounted aft of the compass receiver, on the rack for the radar equipment. Liaison radio includes one transmitter located on the flight deck, under the radio operator's table, and a receiver on the table. Radio compass is located over the wing center section on the right side, and the marker beacon is located in the bomb bay.

Capacity of the oxygen system, originally provided by 5 fixed-position bottles in the upper aft section of outboard engine mounts, has been increased to 26 bottles of 350-psi type, located at strategic points. Pressure scale, translated in terms of altitude is controlled by the user and maintained at a setting 5,000 ft. higher than the indicated altitude.

Although, like other U. S. combat aircraft, the B-24 Liberator has frequently been subject to increases in empty weight because of need for additional equipment and protection dictated by the ever-shifting exigencies of war, it has continued to deliver larger bomb loads, farther and faster. That was its designed intent.

Bomb door hydraulic system: (1) Engine-driven pump, (2) automatic seal coupling, (3) engine pump check valve, (4) relief valve, (5) accumulator, (6) hand pump, (7) emergency flap valves, (8) bomb door selector valve, (9) pressure gage, (10) unloading valve, (11) accumulator check valve, (12) check valve, (13) bomb door emergency and utility control valve, (14) bomb door cylinder, (15) bomb door relief valve, (16) auxiliary pump relief valve, (17) auxiliary pump check valve, (18) emergency cross-over valve, (19) test stand valve, (20) filter, (21) pressure switch, (22) reservoir, (23) emergency reservoir valve, and (24) suction line check valve.



DESIGNING TOMORROW'S PERSONAL PLANE

PART II

By **RALPH H. UPSON**, *Consulting Engineer*

Here the author, one of America's foremost design consultants, sets up the "score card" for five possible types of craft and analyzes each from performance and cost standpoints. The basis for estimating weight and drag is established and applied to each design type.

WE HAVE SET UP A VISION (Part I, June AVIATION) of the kind of performance that ought to be possible for a lightplane, with nothing more than a clean-up of unnecessary drag. This process resulted in approximately doubling the speed, the carrying capacity, and the range of a typical prewar design.

The problem that confronts us now is not merely to "try and get it," but to pick the most feasible path of approach, with other desirable features in mind, using fairly conservative estimates and requirements.

The question of how to arrange the basic elements—fuselage, wing, power plant, landing gear, and tail—will first be considered from a standpoint of weight and drag for the particular purpose intended.

For a preliminary comparison, it will be assumed that we are dealing with single-engine enclosed landplanes avoiding unrecognized, controversial or bizarre features, such as tailless tail-first, and folding-wing types, boundary layer control, laminar-flow contours, novel types of engines, extension shafts, etc. Flaps, however, are now considered well enough established to justify their use for any type of plane. We come, then, to five main comparisons:

1. High vs low-wing (with biplane as a supplemental variant)
2. Strut-braced vs cantilever wing
3. Fixed vs retractable landing gear
4. Tricycle vs conventional landing gear.
5. Pusher vs tractor

For mathematical completeness, each comparison would have to be made for each different possible combination of all the alternatives. The number of different major arrangements is the same as the number of heads-tails possibilities of five pennies, which is 2^5 or 32, without intermediate and incidental variations. But some of these can be literally laughed off, such as a low wing, externally braced pusher with retractable gear.

Other combinations can be restricted by rational engineering judgment to an extent which apparently permits reducing the total number of cases to five. The method of analysis will be clearly set forth, so that anyone not satisfied can set up other combinations or try out possible changes in the weight and drag of component items.

Basic Arrangement of Parts

In laying out a comparative series of designs, we must distinguish between modifications or design features incidental to the particular comparison at issue, and those arbitrarily introduced by habit or fancy. For example, most cantilever wings are of stiff-skin construction, not primarily because they are cantilever but because they usually have been in a class of wing loading that well justifies such construction.

For similarly irrelevant reasons, most externally braced wings are fabric covered, but it would be obviously misleading to compare a stiff-skin cantilever wing with a fabric covered, externally braced wing. It would be as logical to throw in other extraneous differences such as bigger flaps or folding wings.

Taper is of course a more definite consideration in the design of cantilever wings. Not that such a wing must be necessarily tapered (probably the lightest wing in service today is fabric covered, untapered cantilever), but for equal drag and structural efficiency, taper still saves ap-

preciable weight. On the other hand, taper introduces an unresolved cost difference that complicates consideration of other features; hence these comparisons will be made uniformly on the basis of the untapered wing form.

External struts are assumed confined to the high wing, because of their unfavorable interference and structural difficulty above a low wing. For equal wing loading, the beam or lift resisting structure is the only significant

Pete Pilot: 'Kinda slow with that fixed gear, isn't it?'
Ernie Engineer: "A little, but you wanted a lower priced plane."

source of weight difference per sq. ft. between the externally and internally braced wing; and, as will be shown, this increment of weight in a lightplane is relatively small, especially for the assumed one-piece wing.

Consideration of the pusher is here limited to the high-wing type because of the serious problem of wing-fuselage interference in a low-wing pusher; and because vision, the pusher's principal advantage, can be best obtained with a high wing.

Although a major advantage of a low wing is in connection with retractable wheels, a cantilever low-wing is also of advantage with fixed landing gear and is therefore included. High-wing designs, however, will be considered only with fixed gear, because of the relative unsuitability of a high wing to landing gear retraction.

There appears no need to compare the tricycle with conventional landing gear for the more than one wing and power plant arrangement, since the weight and drag difference should run about the same for all. Conventional landing gear is assumed for the high-wing tractor and tricycle gear for the pusher as the most logical arrangements for these two types.

Because of the interest in immediate possibilities, the present comparisons will be based on somewhat less extreme demand as to performance, and more conervative design conditions, than formed the basis for the general possibilities developed in the preceding article. It is assumed that either take-off or cruising power may be the criterion of engine size. For the former condition, power loading will be held constant at a value which will not only limit the takeoff distance but also satisfy any reasonable requirements for climb and ceiling. In everything except the percentage of full power used for cruising, this constant power loading favors a plane of high drag but low weight by making the rated power independent of cruising speed.

The Line-Up

Thus the following actual participants in the contest for design superiority are now simply set down and described, along with the rules of the game.

These are the planes:

Type A—Cantilever low-wing tractor, retractable tricycle landing gear.

Type B—Cantilever low-wing tractor; retractable conventional landing gear.

Type C—Cantilever low-wing tractor; fixed conventional landing gear.

Type D—Braced, high-wing tractor; fixed conventional landing gear.

Type E—Braced high-wing pusher; fixed tricycle landing gear.

The principal comparisons are then D vs. E; C vs. D; B vs. C; and A vs. B.

These are conditions that all must meet:

1. Carry 575 lb. (including 3 persons) of useful load less fuel and oil.

2. Maintain a wing loading of 10 lb. per sq.ft. which, with good flaps (Max. $C_L = 2.6$) will permit landing at under 45 mph; this item reduced 4 percent for pusher to allow for forward center-of-gravity position at full load.

3. Maximum rated power loading: 17 lb./hp., which in combination with the wing loading will control the sea level takeoff distance to safely under 1,000 ft. over a 50-ft. obstacle, even with a fixed pitch propeller.

4. Ultimate range: 600 air miles (fictitious, assuming constant fuel consumption of 0.52 lb. per hp.-hr. with no allowance for climb or variation of fuel consumption) a true speed of 120 mph. at 7,000 ft. Actual range = 500 ± 50 air miles.

5. All wings rectangular, aspect ratio 6, thickness ratio: cantilever 0.15, braced 0.12; metal structure, fabric covered or equivalent in weight.

The appended data on drag and weight are based on the references given, subject to the following qualifications:

The engine weight, including starter, is about midway between present average and minimum weights. Estimated indirect additions to fuselage and tail weights, due to the power plant, are considered as power plant weight. Because of the variable proportion of cruising to rated power, fuel and tank weights are made functions of cruising power; but the balance of the power plant weight remains a function of rated power.

Wing weight includes an increment for the contribution of the tail, or rather that part of the tail which is estimated to depend directly on the wing. As in the case of an all-metal wing, the weight is divided between two terms, the first being the surface weight (constant per unit area for equal wing loading), and the second the beam structure, incidental weights being divided between the two.

Due to the fabric skin, the first-term coefficient is substantially reduced in comparison with all-metal wings; but the second-term coefficient is a little increased. Also the assumed constant aspect ratio, with the relatively small magnitude of the second term, permit combining both into a single term for this particular comparison, with only a difference in the coefficient to distinguish between the weight of the cantilever and externally braced wings.

As may be expected, the landing gear weight is a function of the type, and the weight it has to carry.

Power plant drag, largely chargeable to cooling, is estimated as a fixed proportion of the cruising power. This procedure implies a well-cowled engine with some means of adjusting the quantity of cooling air.

Wing drag, in similar manner to the weight, includes a tail increment, and it also allows for fuselage interference, usually negative because of the overlapping surface.

For the landing gear, the residual drag of a retracted nose wheel is assumed equal to that of a conventional (exposed) tail wheel.

Propeller efficiency values are estimated as being possible for the fixed-pitch wood type, assuming average

Salesman: "... and retractable landing gear too!"
Pete Pilot: "Yes, but how much does it cost?"

shaft speed. The efficiency is assumed the same at cruising as at top speed, but is of course appropriately reduced for climbing.

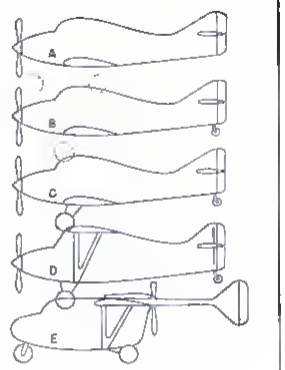
Because certain of the weight items depend on cruising power, the drag (including induced) and efficiency become part of the final weight equation, which can be expressed in similar form for all of the design types, the variation being in the numerical coefficients of the different terms. The weight in turn is fed back into the drag equation from which the cruising power is determined. With the equations thus set up, we are ready to "turn the crank" and see what comes out.

Table I—The Score Card
3-Place Airplanes

Design Type	A	B	C	D	E
Gross weight W (lb.)	2900	2115	2075	2185	2450
*Fuel and oil W_f (lb.)	213	208	232	282	339
Weight empty (lb.)	1412	1332	1298	1328	1536
Useful/gross (%)	36.8	37.0	38.8	39.2	37.3
Rated power (hp.)	129.5	124.5	122.0	137.5	165.5
Cruising hp. (120 mph.)	79.0	77.0	86.0	104.5	125.5
Cruising/rated (%)	61	62	70	76	78
Drag area f (sq. ft.)	4.80	4.81	5.48	6.79	8.04
Wing area S (sq. ft.)	220.0	211.5	207.5	218.5	255.0
**Wing weight (lb.)	320	308	302	298	352
Wing span (ft.)	36.3	35.8	35.3	35.3	39.0
Max. speed (mph.)	139.3	138.4	130.5	126.0	125.8
Max. climb (fpm.)	870	565	540	580	615

A—Cantilever low-wing tractor; retractable tricycle gear
B—Cantilever low-wing tractor; retractable conventional gear
C—Cantilever low-wing tractor; fixed conventional landing gear
D—Braced high-wing tractor; fixed conventional landing gear
E—Braced high-wing pusher; fixed tricycle landing gear.
All for aspect ratio A = 6, cruising $V_{cr} = 120$ m.p.h. at 7,000 ft. rated hp = W/12, or more if required for cruising: W/S = 10; $W_f = 2.7$ hp.-hr. Useful load less fuel = 575 lb.

* Disposable portion (excl. tanks)
** Wing and bracing alone, without tail increment.



Comparative Performance

What comes out in this particular comparison is shown in Table I, the Score Card. It will be noted that no one type can be said to have all the advantages. Even in this somewhat narrow field of weight and performance, each one of the five design types has at least some quality to recommend it. Type A has the best top speed; B has lowest fuel consumption; C has lowest empty weight; D has greatest useful load ratio; and E has best climb. The biplane has been similarly shown (by figures not given here) to have one definite advantage: compactness of dimensions.

But, considering the cost of attaining these various results, the finger of destiny seems to point in the general direction of Types B and C. As between these two designs, C is 64 lb. lighter in weight-empty, but burns about 0.8 gal. more fuel per hour. If, for example, we assume $3 per lb. selling price and 24¢ per gal. of fuel, the price difference of $192 would be made up in about 1,000 hr. This estimate of 1,000 hr. to make up the initial cost difference is probably low, especially in view of the higher relative cost per lb. of retracting gear, still without considering insurance and other fixed charges affected by the purchase price.

But even 1,000 hr. is a lot of flying for a private pilot; so, in spite of the extra top speed for Type B, it looks as if the award for best performance per dollar among these particular designs would have to go to Type C (low-wing tractor with fixed conventional landing gear).

Although this conclusion is at variance with that of previous articles[1] it should be noted that there is no real inconsistency, since the comparison was then on a basis of speed without regard to takeoff. A similar basis for the present case, which with adequate takeoff facilities is perfectly proper, would give a clear-cut superiority to the retractable gear of Type B. Here however, we have granted all benefit of any doubt to short takeoff. So the argument is still wide open and depends largely on how important short takeoff is to be.

On the evidence thus far, uncontested title to the booby prize goes to the pusher, Type E, as the heaviest, slowest, most costly, and biggest fuel imbiber of all five. It excels in the one item of climb only because it needs so much power to do anything else.

But still we have been talking only about performance and its cost. Many considerations of stability, control, vision, access, facility of landing and taxiing, etc., remain, together with possibilities of other variations of arrangement and use. These will be discussed in the next article, along with comparisons of specific features.

[1] Save Money by Spending It—Upsan, Sept. 1944 AVIATION; also Part I of this series, June 1945 AVIATION.

DESIGN DATA

a. Weights

For exploratory or creative design purposes the gross weight is divided into:

1. *Basic or fixed weight* consisting of "payload" (useful less fuel) with everything directly involved in housing such load, including most of the fuselage furnishings, controls and fixed equipment. For a given purpose, this item is constant, except for minor variations incident to the arrangement of the airplane as a whole. Included is a major part of the tail required to stabilize and control the fuselage volume and mass (except power plant). The component weights in this category are estimated as follows for the five comparative design arrangements:

Designs	A, B & C	D	E
Pilot and passengers (3)	510	510	510 lb.
Baggage and extras	65	65	65 lb.
Fuselage and booms	200	207	215 lb.
Tail surfaces	30	28	35 lb.
Controls and fixed equipment	150	150	155 lb.
Totals	955	960	980 lb.

2. *Fuel.* Including oil and tanks and comprising the items having to do with range, this is estimated as a function of the cruising engine power hp_{cr}:

Gasoline	$0 + 2.5\ hp_{cr}$ lb.
Oil	$9 + 0.1\ hp_{cr}$ lb.
Tanks	$6 + 0.3\ hp_{cr}$ lb.
Total	$15 + 3.0\ hp_{cr}$ lb.

of which the consummable portion $w_f = 2.7\ hp_{cr}$.

As noted in the text, this condition is equivalent to the specified range at constant speed, altitude and specific fuel consumption. Actually, the minimum fuel consumption for present lightplane engines occurs at a cruising power roughly 70 to 80 percent of rated. At lower relative power, there is a slightly decreased actual range (but probably increased engine life).

The fuel weight contributes practically nothing directly to the aerodynamic or inertia moment, and hence calls for no tail increment. The last of the three items is of course part of the weight of the empty ship.

3. *Power plant weight.* Here estimates are based on weights of existing engines and accessories plotted against *rated* power for the 50 to 200-hp. range. Re-

sults from n previous study[2] have been used with slight revisions, mainly to allow for an available saving in engine weight and for a starter. The following equations represent the results:

Engine	50 + 1 7 hp (lb)
Propeller (wood)	3 + 0 1 hp (lb)
Miscellaneous	32 + 0 7 hp (lb)
Total	85 + 2 3 hp (lb)

Where the miscellaneous item includes engine mount, exhaust, cowling, scoops, starter, and small increments of fuselage and tail, depending on the power plant weight (and hence on rated hp).

In accordance with the assumed maximum power loading, W/hp = 17 and the above total becomes

$$85 + 147W$$

which applies to designs A, B, and C.

Trial computations show that for designs D and E the required cruising power is impossible of attainment if the rated power is based on the above relation. Hence in these cases the rated power must be increased to:

$$hp_r = bp_{cr}/.76$$

where 0.76 is the power factor for an unsupercharged engine with fixed-pitch propeller at the assumed cruising altitude of 7 000 ft.

This last relation makes the alternate total of power plant weight:

$$85 + 3.29\ hp_{cr}$$

which applies to designs D and E.

4 Wing. Here weight includes flaps and ailerons, struts, carry-through members and an increment (approximately 10%) for the portion of the tail which varies with the wing). In accordance with the writer's published methods[3], the structural ratio or beam weight parameter (for cantilever wings):

$$E = (\phi_s A^2/t) (\bar{y}_s/\bar{y}_c)^2 = 83\,0 \qquad (1)$$

where the aspect ratio A = 6, root thickness ratio t = 15; lateral center of pressure in proportion to center of area $\bar{y}_s/\bar{y}_c = .92$ (untwisted), taper factor $\phi_s = 1.0$ (rectangle).

If W = W_s, the gross weight of the ship, the wing weight is then approximately (for wing loading W/S = 10 and limit load factor n = 4.5)

$$W_w = W[0.275(W)^{1/4} + 6.5 \times 10^{-4} \times Rn\,S^{1/2}/(S/W)] \qquad (2)$$

$$= .9\ (125 + .00075\,W)] \qquad (2a)$$

Here the first term coefficient for fabric covering or equivalent is reduced to 70% of its value for average all metal construction; but the second term coefficient although numerically reduced is increased about 8% in effect due to the neglect of the wing weight moment. Although the supporting data are not as complete as for all-metal wings, it is believed that the second term coefficient is liberal for continuous metal beam flanges and associated members.

By use of a trial value of W = 2 200 lb it will readily be seen that for this class of airplane the second or beam flange term of the wing weight equation is small enough to be approximated by a constant value within the parentheses in Equation 2a. Hence for present purposes we may put for designs A, B, and C:

$$W_w = 1.60S = 160W \qquad (3)$$

of which about 22% represents beam material.

The remaining 76% or 125W can be assumed the same for the externally braced wings. The beam elements are then represented by spars, struts, fuselage follow-through members, and connecting fittings. An independent estimate of these, with credits for reduced shear and torque, gives .025W, or a total for design D:

$$W_w = 1.50\,S = 150\,W \qquad (4)$$

and, slightly modified for design E:

$$W_w = 1.52S = 152\,W/.96 = 158\,W \qquad (5)$$

5. Landing Gear. This includes retracting mechanism, if used, with wheel wells and any additional reinforcement required. It is estimated as follows for the five design types (for the approximate range and size involved):

Design	Landing Gear Wt. (lb.)
A	20 + .087 W
B	15 + .076 W
C	10 + .055 W
D	10 + .059 W
E	13 + .073 W

The above figures are made fairly liberal to allow for long stroke and a reasonable amount of fairing.

6. Weight Summary. By collecting the constant terms, those in W, and those in cruising power from the last five items, we get the following expressions for the gross weight W:

A	1075 + 404 W + 3 hp_{cr}
B	1070 + 335 W + 3 hp_{cr}
C	1055 + 362 W + 3 hp_{cr}
D	1070 + 209 W + 9 29 hp_{cr}
E	1093 + 231 W + 9 29 hp_{cr}

Evaluation of the total weight thus still involves one unknown—the cruising power—which of course depends on the drag.

b. Drag and Efficiency

1. Basic drag, analogous to the basic weight, is essentially that of the fuselage and the part of the tail surface required to stabilize and control it (pins booms in the case of the pusher). It is estimated

Salesman: "... and complete to retractable ashtrays!"
Pete Pilot: "Why not retract the whole thing?"

as follows for the respective design types, in terms of the drag area f = SC_{DP}, where S is the wing area and C_{DP} is the coefficient of all drag which is constant with respect to lift:

A, B, and C: 2.00; D: 2.20, and E: 2.40. Terms are in sq. ft.

2. Fuel drag is assumed zero in all cases.

3. Power plant drag (cooling) area is assumed for all types:

.0063 bp_{cr} (sq. ft.)

equivalent to making the net efficiency .06 lower than the propulsive efficiency at cruising speed.

4. Wing drag. Including struts, interference, and tail increment, this is estimated to involve areas as follows for the respective design types (sq. ft.):

A, B, and C	0 + .010 S = 0 + .0010 W
D	3 + .012 S = 3 + .0012 W
E	4 + .0125 S = 4 + .0013 W

The low wing value is on a basis of C_{DP} = .0067 wind tunnel value (NACA TR 669, airfoil 23015) for R N = 8.0 × 10^6, corrected to .0070 for R N = 5.7 × 10^6 — .004 fuselage interference (NACA TR 540 and 678) + .0025 for surface irregularities + .0009 tail increment.

5 Landing Gear drag. Including tail wheel and an allowance for residual drag of retracted wheels, this is similarly estimated as follows (sq. ft.) with exposed wheels partially faired (NACA TR 485, 517, and 522; TN 788):

A and B	0.20 + .9
C	3.5 + .0025 W
D	3.5 + .0003 W
E	4.0 + .0035 W

6. Propeller efficiency η for fixed wood blades, at cruising speed of 120 mph:

A and B	0 78
C	0 77
D	0 78
E	0 74

c. Power and Performance

1 Thrust power at airspeed σ in mph is given by the simple formula:

$$\eta\,hp_{\sigma r} = \frac{\sigma\,\sigma f}{146\,000} + \frac{.39\,W}{\sigma\,e\,A}\left(\frac{W}{S}\right) \qquad (6)$$

in which the span[2] factor e has been given a mean effective value of 0.85. By substituting the assumed 6" .811 (at 7 000 ft.), A = 6 and σ_{cr} = 120 mph, (6) becomes:

$$\eta\,hp_{cr} = 9.55f_a + .0067\,W \qquad (7)$$

where, from items 3 and 6 (section 6), $\eta_a = \eta - 9.55 \times .0063$, and f_a is the summation of f values from items 1, 4, and 5 in section b. As for the term in W, its constant coefficient allows for the extra tail load in Type E, but not for the considerable induced interference commonly found in this type of plane.

2 Cruising power from Equation (7) reduces to:

A and B	hp_{cr} = 29 2 + .0226 W
C	hp_{cr} = 21 3 + .0262 W
D	hp_{cr} = 38 9 + .0300 W
E	hp_{cr} = 44 9 + .0330 W

3 Gross weight W is obtained by solving the equations in item 6b after substituting hp_{cr} from c2. This known weight in turn is used in determining other desired characteristics: hp_{cr}, thus area f consumable fuel and oil weight W_f, and other weight components.

4 Weight empty W_e = W − W_f − 575 from which useful load = W − W_e.

5. Top Speed (mph at SL):

$$v_m = 53\left(\frac{shp}{f}\right)^{\frac{1}{3}} - \frac{W}{3\,\eta\,shp} \qquad (8)$$

for σ = 10, η = .86, and A = 6.0. Or alternatively use NACA TR 408.

6 Climb (fps at SL):

$$C_m = 17\,300\,\eta hp/W - 620\left(\frac{f}{\eta hp}\right)$$

for propeller C_m = 1.2 (empirically from NACA TR 408) for the same characteristics as item 5, η hp being still the thrust power at top speed, not in actual climb.

The procedure represented in equations (6) and (8) assumes that cooling power increases directly with air speed and density.

These convenient formulas for light plane design are from a number of such formulas which we aim to present, on a basis for broader use, later in this series.

[2] "Save Money by Speeding It" Sept. 1944 AVIATION.

[3] "Performance Dictates Design" *Journal of the Aeronautical Sciences*, July 1940.

Time-saving resourcefulness, which make possible design and construction of P-80 in just 143 days, was typified by this quickly built engineering department building. Made almost entirely of engine box lumber, it was erected in just ten days.

HOW WE ENGINEERED THE LOCKHEED SHOOTING STAR

By C. L. JOHNSON, *Chief Research Engineer, Lockheed Aircraft Corp.*

The AAF gave Lockheed just 180 days to create and deliver the first P-80, radical new jet-propelled fighter. Here's the first-hand story of how it was done—in the unbelievable time of 143 days.

WHEN LOCKHEED AIRCRAFT CORP. undertook in 1943 to engineer and construct a radically new jet-propelled fighter airplane for the Army Air Forces in the hitherto unheard of time of 180 days—from start to finish—it was realized that an entirely new approach to the entire project would be necessary.

Because of the extremely tight time factor, Lockheed's conference system of engineering would not work out, and it was also apparent that the job could be completed successfully only if all responsibility and authority were concentrated in one man. Our engineering department had wanted for some time to engineer and build a plane from start to finish, and the XP-80 Shooting Star provided that opportunity.

Under Hall L. Hibbard, vice-president in charge of engineering, a separate group was set up in the company's engineering department for development of the P-80. Mr. Hibbard was able to visualize the advantages that would be gained if complete responsibility were concentrated in one spot; consequently, as chief research engineer, I was given a completely free hand to organize and direct this project.

Since speed was the essential factor, we began by securing a letter of intent from Wright Field. This was accomplished in one day by the simple expedient of walking the necessary papers from one office to another until they were completed. The company was then committed to deliver a jet-propelled fighter plane within 180 days from the time the last signature was received.

Our first problem comprised assembling of the necessary personnel and a decision on the best location for our project. My assistants were E. D. Palmer, head of our special projects department, who worked with W. P. Ralstorf, now P-80 project engineer, and A. M. Viereck, division manager of our engineering experimental department, who directed the shop group with L. F. Holt as assistant. Within 35 days we had a total of 23 engineers and 57 skilled mechanics assigned to the P-80 project. At our peak there were 128 men, 23 engineers, and 105 shop men in our group. Inspection was also responsible directly to me.

Because of the strict security regula-

tions imposed on the work, it was necessary to construct a new building away from other shop and office areas. A temporary building, of old engine boxes and canvas covering about 11,000 sq. ft., was erected by Lockheed plant engineers in ten days in an open area beside our wind tunnel. This enabled us to make use of equipment in the wind tunnel model shop, and it later proved very convenient for the frequent tunnel tests we ran on various parts.

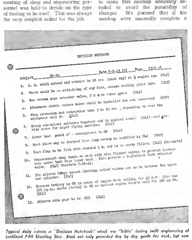
At that time, machine tools were very difficult to secure, and we were forced to buy out a complete local machine shop in order to equip our layout. A minimum amount of work, actually about 4 percent of the total, was done in the regular Lockheed fabrication departments; everything else was held in one spot.

With our basic design laid out and the engineering and shop groups organized, a master schedule was developed. As soon as the major components were roughly designed, a joint meeting of shop and engineering personnel was held to decide on the type of tooling to be used. This was always the very simplest suited for the job.

On most other parts, Viereck worked out his own tooling directly from the part drawings. The engineers and shop men worked together directly throughout the project, and during the last three weeks practically all personnel were doing actual labor on the airplane. Inspectors worked directly from the drawing boards to the airplane, and with excellent results.

The bible of the P-80 project was our *Decision Book*, in which we made daily entries of the decisions made by the top group. Every decision was initialled, and any changes or deviations later agreed on were noted beside the original decision. In addition to providing a day-to-day guide to our work, the *Decision Book* now provides an accurate record of what was done at every stage of the airplane's development. Entries for a normal day might run as shown in the accompanying illustration.

Our first milestone was completion of a wooden mockup of the airplane 19 days after work started. We decided to make this mockup unusually detailed to avoid the possibility of changes. We guessed that if the mockup were unusually complete it might discourage changes. As it worked out when we held mockup inspection on the 19th day of work, no changes were suggested and a few eliminations were made.


DECISION NOTEBOOK

Subject XP-80 Date 7-2-43 (9) Page 1320 -6

1. L. G. shall extend and retract in 10 sec. (each way) at ½ engine rpm (CLJ)
2. There shall be no anti-icing of any kind, except heating pitot tube (CLJ)
3. Use vacuum gage selector valve, T & B vs other gyros (CLJ)
4. Alternate static source valve shall be installed but not connected (EDP)
5. Flap extension and retraction time 3 to 10 sec., depending on what the equipment will do. (CLJ)
6. Group electrical switches together and in logical order. (CLJ)—and provide cover for night flying switches (CLJ)
7. Lower inst. panel 1" - arrangement is OK (CLJ)
8. Dust lines may be derived from clay mockup as modified by CLJ. (EDP)
9. Dust flap to be flat with rounded L.E. and is to carry fillet. (CLJ) (Obsolete)
10. Interconnect wing tanks on each side with flapper valves to prevent leakage into outer tank from inner tank. This permits a 3-position tank selector valve. (CLJ) Obsolete 7-16-43.
11. The aileron hinge moment limiting relief valves are to be between the valve and cylinder. (CLJ)
12. Present battery is OK in spite of engine book calling for 40 A.H. Also our 320 sq-in. ducts (total) is OK as against engine book's call for 350 sq-in. (CLJ)
13. Aileron skin gage to be .025 (CLJ)

Typical daily entries in "Decision Notebook" which was "bible" during swift engineering of Lockheed P-80 Shooting Star. Book not only provided day by day guide for work, but now provides accurate record of development.

Starting point for the P-80 project was the engine, which was to be supplied by the British. We had the drawings of this power plant, and after several months a wooden mockup of it was developed; but an actual engine did not arrive from England until the 132nd day of the project.

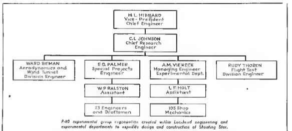
Nevertheless, we laid out the airplane—on the basis of specifications provided—around an engine none of us had ever seen. During our talks with Wright Field we had guaranteed certain performance figures and also provided a general outline of the plane we were to build. Our airfoil was based on an NACA equation for a highly developed laminar flow section. This type of wing would not work out well with a propeller; it was the first time the type had been given a fair chance to prove all its merits.

In spite of the fact that little test data was available on this airfoil, we went ahead and built the wing on the basis of our calculations, with the fond hope that wind tunnel tests would later bear out the figures. Fortunately this worked out, and our gamble in selecting an untested wing section gained us a tremendous advantage as far as schedule was concerned. We had of course, been working within compressibility ranges with the P-38 Lightning for several years and probably had an advantage in that respect over most other groups.

About the only change found to be necessary in the P-80 was a slight modification to improve the craft's stall characteristics and to make it less sensitive to minor changes in the wing's contours. For example, we discovered that the slight surface displacement caused by mechanics and pilots walking on the wing surface was sufficient to throw the plane completely out of trim. This problem was solved, and the P-80 today has excellent stall characteristics and a high degree of stability.

Good low aileron forces were achieved by application of hydraulic aileron boost, as developed in the P-38 and the Constellation four-engine transport. As in the P-38, the Shooting Star's aileron boost system has made the plane exceptionally maneuverable at all speeds and provides ease of control that will be highly satisfactory from the standpoint of combat pilots.

Our main problem in designing the fuselage of the P-80 lay in providing accessibility to the engine installation and installing the large amount of



P-80 experimental group organization created within Lockheed engineering and experimental departments to expedite design and construction of Shooting Star.

armament. Once these problems were solved, we were able to go ahead with our development of a fuselage with optimum aerodynamic characteristics.

Wing and fuselage sections were designed, built and ready for mating on the 83rd day, right on schedule.

One thing that should be emphasized at this point is the fine cooperation we received at every stage of the P-80 work from Wright Field and especially from the officers assigned to our project. For example all Government-furnished equipment, such as guns, radio, wheels, tires, etc., were in our hands six days after we started work. Without that type of support we could never have succeeded in meeting the schedule.

Naturally the pressure on everyone concerned was intense. Everyone was time conscious, and to keep all hands apprised of progress we set up a big score-board calendar with the title Our Days Are Numbered. Every morning, the preceding day was crossed off—and some mornings that job was like pulling teeth.

At all times the relationship between engineering and the shop, and between supervision and the men, was extremely close. The engineers would finish a sketch, take it into the shop, and hand it to one of the men who would make the part. Or sometimes a mechanic would work up a part that was needed and hand it to us to make a drawing. That such a relationship could exist is indicative of the high type of men we were able to assemble.

Toward the end of the job, the pressure on our entire staff became even more intense, almost too much so. Early in the project we determined that we would schedule the work on the basis of a 10-hr. day and 6-day week. No one worked Sundays. However, as the last weeks rolled around we were experiencing a sickness rate that ran as high as 25 to 30 percent daily, due to poor facilities and absence of heating, and work would have been seriously handicapped had the project extended another few weeks. It was necessary to enforce the 6-day week for supervisory personnel since our small staff could not afford the loss of even one key man due to illness.

As various assemblies were completed, tests were run to check our calculations and assure the highest possible safety factor for the new plane's initial flight.

Before the P-80 left its hangar, we suspended the ship by belly bands and tested it for flutter and vibration. A complete load of fuel was pumped in and out, and the entire craft was shaken to test flutter modes. Complete brake tests were run before the plane moved an inch. We almost pulled down the shed during tests of the cockpit canopy release mechanism.

Once this phase of the work was completed, the airplane was disassembled and trucked to an Army test base where the first flight was made. On the 139th day of work the engine ran the first time the starter button was pressed, and one the 143rd day the airplane was accepted by the Army and pronounced ready for flight. We had beaten the contract schedule of 180 days—and our own private schedule of 150 days.

At all times, the entire project was kept as tightly restricted as possible, not only for Army security reasons but because we were fearful that the presence of other groups would result in delay. No other Lockheed departments were brought into the picture at any time—costs, scheduling, purchasing, all phases of the work were in our hands.

One evidence of the efficiency of this system as it was applied to the development of the P-80 is the unusually low cost of the prototype, only 63 percent of what it cost to build the prototype of the XP-38, a conventional twin-engine fighter constructed by the conventional system.

The Shooting Star was built with only 700 drawings, a factor which simplified the task of supervision considerably. Palmer and I personally inspected every drawing every day, and a close personal liaison was maintained between top men and all phases of the work.

The wartime advantage gained by the successful development of a revolutionary new fighter plane in less than six months is obvious. In one jump our Air Force moved ahead technologically of every other air force in the world.

However, we do not feel that a large airplane would respond to a similar development program. The problems involved are far too complicated and of too great a scope to be handled by a staff of 128 men. But we do feel that we have established the ability of a well organized research department to plan and carry out an advanced development program quickly and efficiently in an experimental department organized within an engineering department. As stated, we had wanted to do this sort of thing for a long time, and all feel well pleased with the results of the experiment, especially since it provided the United States with another advanced warplane.

Aeronautical Supremacy Demands Jet And Rocket Research

Republic P-47 ready to launch its ten 5-in HVARs (high velocity aircraft rocket), lethal and accurate missiles which first proved their worth in the St Lo breakthrough and now being used with deadly effect against the Japs.

PART I

By ROY HEALY, *Vice-President, American Rocket Society*

ONE OF THE FEW beneficial aspects of this war has been the belated emergence of rocket research from the basement workshops of amateur experimenters into the great laboratories of governmental and commercial agencies

Where in prewar days small groups of enthusiasts surreptitiously conducted experiments in isolated fields (frequently with illicitly obtained and transported materials, ever fearful of the descent of the local constabulary armed with prohibiting ordinance), today large bodies of research technicians are engaged in development and testing of the numerous rocket and jet propulsion devices evolved since the start of this conflict. This rapid mushrooming of rocket research, with the attendant publicity given the many spectacular applications of jet power lends considerable interest to speculations regarding the extent of postwar experiments in this field.

It is clear that many of the purely military devices utilizing rocket and jet power will not have direct commercial applications, although the basic propulsion methods may have numerous uses. At this writing all indications point to continued research, by all major powers, in the field of rocket weapons. The extent of government financed research in the United States will depend largely on the prevailing feeling of the people, either for disarmament or for a militarily strong nation

This, in turn, will be affected by the success or failure of the major powers to reach amicable agreements at the peace conferences. Should it appear that all international disputes can be settled by a world organization, and the outlook be peaceful, research may be placed on a small and slow moving scale, reminiscent of the prewar years. But, should further conflicts be considered even a remote possibility, then military research will be continued on a vast scale with numerous organizations involved in the development and continuous improvement of rocket and jet weapons

". . . The first essential of the airpower necessary for our national security is preëminence in research. The imagination and inventive genius of our people—in industry, in the universities, in the armed services, and throughout the nation—must have free play, incentive, and every encouragement. American air superiority in this war has resulted in large measure from the mobilization and constant application of our scientific resources.

"Comprehensive research, both within and without the air services, must be expressed in inclusive and continuing programs. Only in this way can our air forces reflect at all times the rapid advances in aerodynamics, physics, chemistry, electronics, the sciences basic to rockets, jet propulsion, radar, and revolutionary developments as yet unconceived" — General of the Army, H.H. Arnold Commanding General, Army Air Forces.

Forecasting startling future developments, this rocket expert declares that for peace or for war unceasing work in this new field is vital if America is to maintain her place in the skies.

Present research on jet propelled devices is conducted on a cooperative basis between various military services, civilian-operated government agencies, and commercial concerns. The foremost government body connected with development of rocket devices has been the National Defense Research Committee, a division of the Office of Scientific Research & Development. Various divisions of NDRC have been undertaking solutions of the myriad problems involved in the design and application of rocket and jet equipment. The Research & Development Service of the Army Ordnance Dept., and the Navy Bureau of Ordnance, coordinating with the various using services, have developed and put into production rocket projectiles of impressive performance, the majority of which are still classified as confidential

The technical trends to be expected, both for the remainder of this war and in any postwar program, can readily be summed up as, first, an increase in range, accuracy, and lethality of the many existing rocket weapons; and, second, introduction of directional controls in the larger longer-range missiles

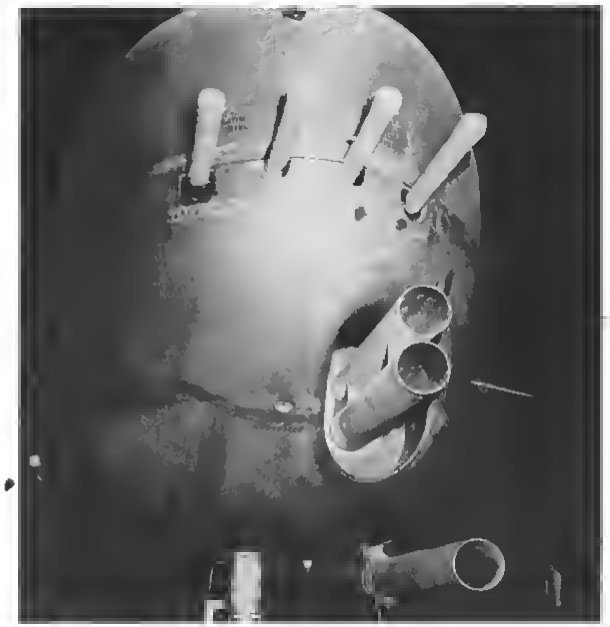
Although new and as yet unreported devices may evolve, the following weapons which have emerged during this war will undoubtedly be the focal points of most further development.

Aircraft Rockets

The natural combination of high speed aircraft and large caliber rocket shells, launched from simple, low drag, easily installed wing posts, was one of the major innovations of the war. Both the AAF, at its new experimental rocket field at Dover, Del., and the Naval Air Force, at its huge Inyokern, Calif., research and training base, are pushing engineering on larger, faster, and more powerful aircraft rockets, and also on more efficient methods of launching them from fighter, attack, and bombardment aircraft. Although the 21-cm. 240-lb rocket (launched from the Me-109's and FW-190's at our bomber fleets, in the Luftwaffe's abortive attempts to halt demolition of Germany) is larger than anything the Allies have yet put into combat, experimental rocket projectiles are now being tested which will dwarf the German's best aircraft rocket, and use of giant rockets may be expected against Japanese targets.

The AAF introduced its first rocket projectile, the M-8, weighing 40 lb and having a diameter of 4.5 in. in the CBI. theater early in 1944. Fired from clusters of paper-plastic tubes mounted under the wings of P-40's of the 14th AAF and P-51's and P-38's of the 10th AAF these rockets were found effective against Japanese targets in China and Burma.

Hardly had the M-8 gone in service when a new and more powerful rocket, the 5-in HVAR (high velocity aircraft rocket), of several times the weight and potency of the initial round reached the combat service test stage. This round requires no launching tubes and is suspended from simple sheet metal posts fastened to the undersurface of the wing. Its lethal effect and accuracy was proven in its debut during the St. Lo breakthrough when,



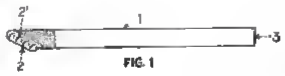
Heavy firepower possible for aircraft through rocket projectiles is previewed in this North American B-25, armed with three rocket launchers in addition to 50-cal. machine guns. (AAF photo)

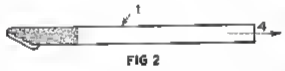
fired from P-47's of the 9th AAF, it struck telling blows against Nazi tanks, trains and truck columns. Most AAF fighters are now equipped to carry ten of these potent missiles which are now being used with deadly effect on Japanese armor, pillboxes, anti-aircraft batteries, shipping and rolling stock.

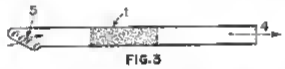
It is believed that the airborne rocket will gain importance as an aerial combat weapon, used both by interceptors and defensively by bombers, because of their longer range and large lethal radius when compared with aircraft cannon shells. Nazi aircraft, in the Luftwaffe's dying attempts, were reported equipped with rapid fire reloadable launchers. Development of internally mounted rocket launchers is an endeavor that offers considerable promise, particularly in connection with jet aircraft at whose high speeds externally mounted rockets would create prohibitive drag.

Anti-Aircraft Rockets

Anti-aircraft rockets have been in use since 1939, first by the British while they were short of the more accurate cannon, then by the Russians in the defense of Moscow, later by the Germans as their anti-aircraft batteries were depicted and, of late, by the Japanese against our bombers. The possibility of control or even limited correction, of the long burning rocket carrying a large explosive head, makes the anti-aircraft rocket a likely subject for postwar research. Present anti-aircraft rockets do not possess sufficient range to menace high altitude bombers, but they have proved effective against low altitude attacks. Various forms of these have been used, some carrying high explosive heads, others showering phosphor pellets on the aircraft; also, many versions of the wire-tailed snare rocket have been put in combat.







Germany had a big lead over U S in developing jet and rocket power plants, as is shown by this basic patent drawing on impulse jet engine later used to power V-1 buzz-bomb. Patent was filed by P. Schmidt of Munich in 1931.

Rocket-Accelerated Bombs

During the Mediterranean campaign, the Germans experimented with rocket-accelerated bombs, for greater penetration of warship deck armor, and also with bombs having radio control devices on their tail surfaces for making limited corrections during descent. With further improvements in devices used by surface ships to elude bombers (such as the reverse bomb sight which aids in dodging falling bombs), the jet-accelerated bomb, with its higher velocity and using a radio controlled tail assembly for corrected descent, will tremendously increase the potency of the high altitude bomber.

The trend toward underground factories which in another war might turn mankind into a troglodyte race, accentuates the advantage of the penetrating ability of the rocket bomb.

Rocket Torpedoes

Being simpler, cheaper, and possessing higher velocities than the conventional marine type torpedo, rocket-propelled torpedoes, both for shipboard and aircraft launching, will probably be seen in active service. Utilizing a solid-fuel driving charge to replace the complex alcohol-steam turbines now employed as motive power, the rocket torpedo will be as cheap and as easily produced as a bomb. More advanced designs of aerial torpedoes may use a stub wing for greater range and may incorporate controls similar to those of the Henshel 293 rocket-glider bomb to allow attacks to be made from outside the ever-increasing range of shipboard anti-aircraft batteries. Research will not be neglected on aircraft-launched controlled rocket-glider bombs for use against land, as well as marine, targets.

Ground Force Rockets

Multiple rapid-fire launchers for infantry, naval, and amphibious attacks have been assuming a role of increasing importance as the war rolls toward Tokyo. Lightweight launchers on landing craft, tanks, amphibious trucks, and even jeeps, used in our island landings, have proven capable of saturating enemy held areas with devastating firepower.

Indicative of the importance attached to rocket firepower is the Navy's recently revealed expectation of expending $100,000,000 worth of this type ammunition monthly during 1945. The Army has an estimated $12,000,000 monthly allocated in this field, and these estimates may be increased if the already over taxed production facilities can be expanded. Aside from vehicle-mounted launchers, the infantry's "jungle launcher" has given the lone soldier an artillery weapon equivalent, in size of the rocket it projects, to a 105-mm. howitzer.

Takeoff of experimental German rocket before Nazis came into power. After Hitler's rise in 1933, secrecy shrouded further developments results of which were not shown to world until V-1 and V-2 attacks on England.

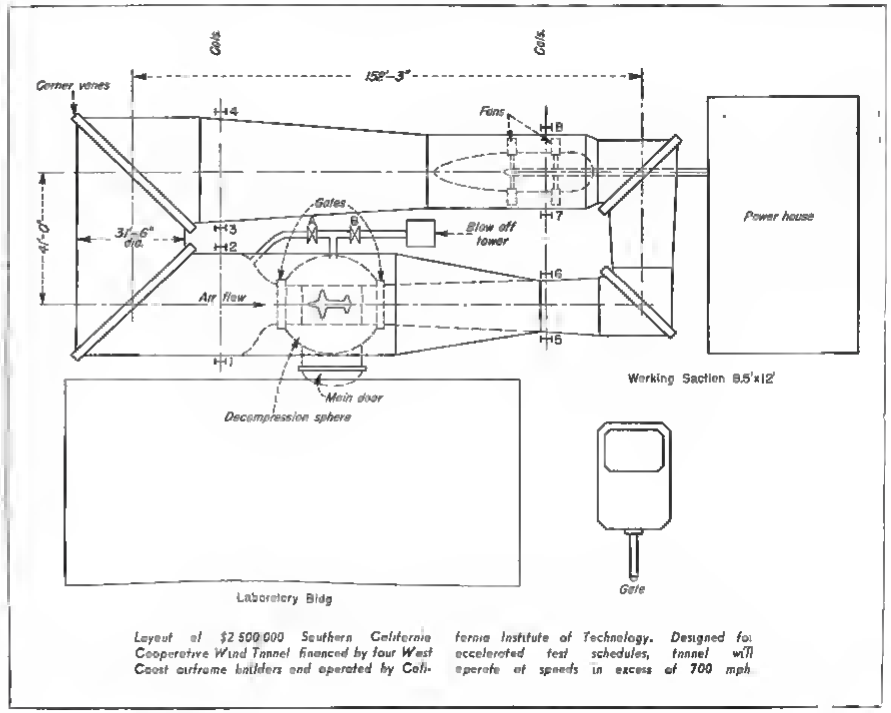
NEW WIND TUNNEL REACHES SONIC-SPEED RANGE

• The following members of the California Institute of Technology and the Southern California Cooperative Wind Tunnel staffs were primarily responsible for the design of major elements of the tunnel and prepared most of the basic material from which this article was written: Messrs. A. L. Klein, E. E. Sechler, M. Serrurier, L. G. Fenner, P. V. H. Serrell, A. Feyer, J. E. Smith, and F. M. Graf.

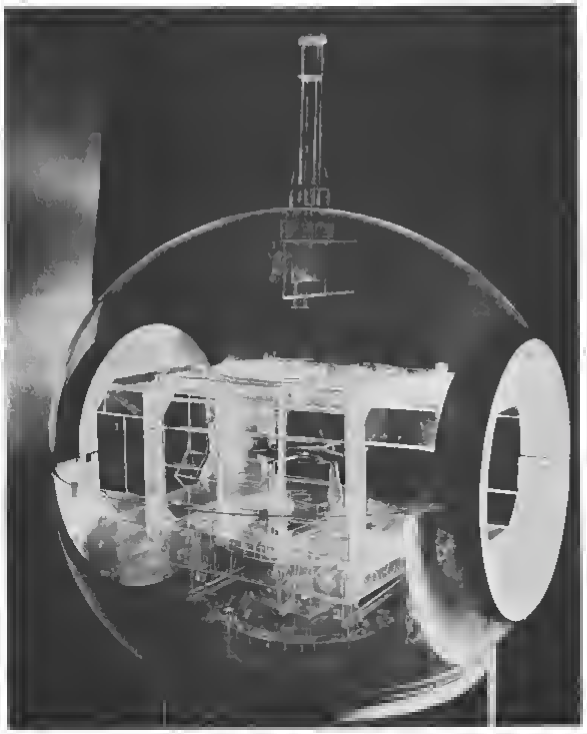
By **CLARK B. MILLIKAN**, *Acting Director, Guggenheim Aeronautical Laboratory*

Specially designed for fast test schedules, cooperative venture financed by West Coast airframe builders embraces new features enabling analytic checks at over 700 mph.

INAUGURATION OF THE SOUTHERN CALIFORNIA Cooperative Wind Tunnel in Pasadena places in service the first such research facility designed specifically for accelerated testing schedules. Among many new features of this large variable-density, high-velocity tunnel are several which are, up to now, unique. First, there is a decompression sphere enclosing the model and working section region; second, movable and interchangeable working sections on model tables; third, a multi-stage driving fan with



Layout of $2,500,000 Southern California Cooperative Wind Tunnel financed by four West Coast airframe builders and operated by California Institute of Technology. Designed for accelerated test schedules, tunnel will operate at speeds in excess of 700 mph.



Plastic scale model of working section of tunnel, showing model plane in position on 50,000-lb. balancing system. Working section is enclosed in steel sphere so that if it is necessary to get at model under test this portion can be isolated from rest of tunnel and pressure or vacuum of 90% of system is undisturbed.

great flexibility of control; and, fourth, a model suspension system incorporating hydraulic-force measuring elements and electrical recording devices permitting test data to be automatically printed and entered on punched cards for machine computation.

This tunnel is also unique in its ownership and operation arrangements. Four aircraft companies shared in its cost, Consolidated Vultee and Douglas each assuming one-third, and Lockheed and North American one-sixth each. One half the design costs were carried by the Curtiss-Wright Corp., which is building an essentially identical tunnel in Buffalo. Direction and operation will be by California Institute of Technology staff of approximately 35 full-time specialists.

Let us consider the Cooperative Tunnel's new features in more detail.

The decompression sphere surrounding the working section is 31½ ft in dia. Its model table entrance is closed by a 12-ton steel door, 19 ft in dia. Two gate valves cut across the airflow circuit up-stream and down-stream of the 8½ × 12 ft working section. Rapid hydraulic operation of the gates and door permits the working section region to be hermetically sealed when testing is in progress. If it becomes necessary to contact the model, the working section can be sealed off from the balance of the tunnel and brought quickly to atmospheric pressure without loss of pressure or vacuum in the remaining 90% of the tunnel.

Second unique feature is the use of huge steel tables or model carts which carry the models into and out of the sphere on steel rails. Each has a different type of model support: wing tip, tripod, or NACA double strut arms. Two of the carts can be loaded or unloaded while the third is in place for a test, virtually multiplying the testing capacity by the number of carts, since no installation time and but a few minutes of hookup time ties up the working section between actual tests.

The third unique feature is made necessary by the fact that the tunnel reaches speeds in the 700 mph range and very large Reynolds numbers by operating either at very low or high air density. Three compressors, located in the power house, can pump the tunnel to 45 psi. gage pressure in about 3½ hr., or evacuate it to ¼ atmosphere, or even to 1/10 atmosphere if required.

The problem of absorbing the full hp over a range of densities of 16 to 1, corresponding to operation between these pressure limits of 4 to ¼ atmospheres, required that an unusual fan system be designed. Two propeller type fans, mounted in tandem on a single shaft, are driven by two electric motors having a total of 12,000 hp. This combination gives essentially the speed control and regulation characteristics of a full Ward-Leonard power plant system at a much reduced cost.

About 1,500 tons of steel plate, approximately 1 in. thick, were used in the construction of the tunnel. Since it is an air tight, single unit without expansion joints, temperature change expansions are accommodated by providing spherical ends (which offer no horizontal restraint) on the eight supporting columns. Horizontal restraint is provided by a pin midway between the third and fourth columns and a link between the tunnel and the base of the seventh column.

Cooling for continuous operation at a power input of 12,000 hp limits air temperature to about 125 deg. A radiator, which removes 500,000 Btu/min., is located in a tunnel corner just upstream of the throat contraction. It consists of 80 units of finned copper coils, each having three rows of tubes in depth.

To insure the smallest possible pressure drop in the radiator the finned coils are placed in the plane of the corner ellipse rather than at right angles to the tunnel axis. Corner vanes turn the air 45 deg. and send it at right angles to the radiator face. About 3,600 gpm. of cooling water is circulated, being cooled in a tower and entering and leaving the radiator through the tunnel corner vanes which support the radiator.

A dehydrator controls humidity to eliminate inconvenience and complications which accumulation of moisture would impose. An air-to-brine heat-exchanging coil, with the brine cooled by ammonia piped into the tunnel from a nearby commercial refrigerating plant, reduces the temperature of the air passing over it to about 40 deg. F.

Tunnel air can be circulated through the dehydrator by means of a 3,000 cfm. circulating fan; and fresh air, entering the tunnel through the compressors, passes over the dehydrator enroute.

Requirements of the fan system are unusually severe. Operating at highest efficiency over the entire range of tunnel pressures, it must absorb the entire power input of 12,000 hp. Moreover, the pressure rise across the fan must be reasonably uniform over the cross section of the tunnel, and the flow leaving the fan must be closely axial in direction.

These requirements are achieved by two identical stages, each composed of a 16-blade, 21 ft 9½ in. propeller-type fan, and a non-rotating adjustable set of 12 pre-rotation vanes mounted upstream of each fan. The fans are coaxially mounted with a clutch between the fan hubs, making it possible to use either both stages or the upstream stage only. Fan blades are of forged aluminum alloy, held in socket assemblies bolted to flats on the periphery of a 7-ft dia. hub.

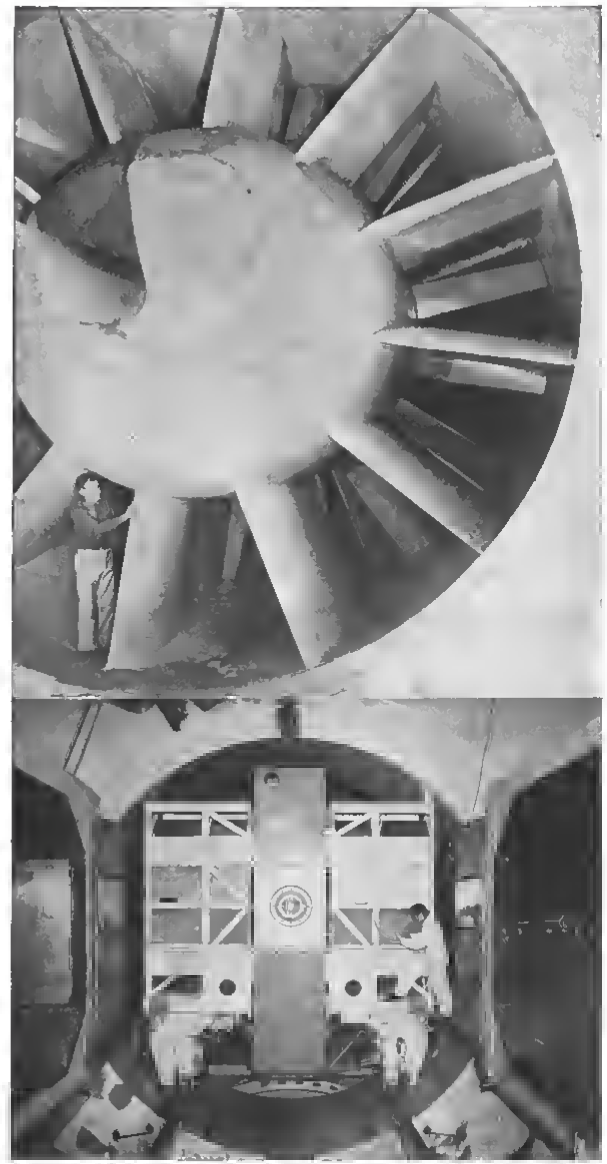
The blade sockets are forged alloy steel cylinders flanged at the hub attaching ends. Blades are rotatable on three angular contact ball bearings, the outer pair being stressed to carry centrifugal force loads of about 100 tons. Two bevel gear units and a planetary gear unit alter blade pitch, the latter requiring 2,600 turns for one turn of the blade.

The 16 flats on the outer periphery of the hub weldments are machined to give the blade axis an upstream angular inclination of 1 deg. 18 min. from the plane of rotation. This arrangement causes the centrifugal force moment on the blade to counteract a portion of the air thrust moment.

When the downstream fan blades are feathered, the disengaged clutch permits it to windmill to prevent Brinnelling of the roller bearing races. A 16 in. dia. hollow steel shaft, 30 ft. long, connects the upstream fan and the motors. Motors and drive shaft are connected by an extended type flexible coupling which permits an offset of

(*Turn to page 254*)

Size of 16-blade, tandem-mounted fans and set of twelve prerotation vanes is clearly illustrated by workmen, shown inspecting pre-rotation vane. Drive shaft is enclosed in housing extending (left center) from nacelle to power house outside tunnel.



Models to be tested are mounted outside tunnel on one of three carts, such as that shown here moving into working section under its own power. Connections can be quickly made so that tests can be run while other two carts are being set up, feature which greatly increases test capacity of tunnel.

RANGING THE BUDGET IN THE POSTWAR LABORATORY

PART VII OF A SERIES

By **K. R. JACKMAN**, *Chief Test Engineer*
Consolidated Vultee Aircraft Corp., San Diego

Continuing his critique of financial planning for research, Mr. Jackman details budgetary factors and emphasizes their vital role. He then compares the "docket" and "case" systems at cost control, presents specific breakdowns of job and salary classifications, samples personnel distribution in three typical aircraft laboratories, and gages research needs for the coming aircraft market.

"Budgeting is the arsenal of financial management, and its sentinel is cost accounting."—Management Maxim.

WE HAVE PRESENTED (Part VI June AVIATION) a few of the available figures to justify postwar planning in industrial research laboratories to the extent of approximately 2 percent of gross sales. Few aviation companies can boast of this carefully planned research expenditure—but would not the progress, advanced designs, and additional markets made available by such far-sighted research policy justify the expenditure? Trials in other industries have paid handsomely.

Convair's high altitude research required massive equipment. Appropriations for the San Diego laboratory were gaged in sufficient detail to include personnel clothing, gloves, accessories, and the like, as well as the financial specifications for refrigeration equipment and the 80,000-ft., 100 deg. F. chamber.

With the appropriation, to development and testing, of the necessary funds, buildings, equipment, and personnel, the obligations of the company are not filled. The board of directors of a progressive aviation corporation cannot, as it advances $1,000,000 to the laboratory director for the new year, reasonably say: "There you are, now set-to—research!" Careful financial and budgetary planning is necessary to economically use appropriated funds.

Since very little has been written on laboratory budgeting, the writer has attempted to collect, in these current Part VI and Part VII articles, a few pertinent facts as applied to aviation research, in order to promote public discussion of postwar laboratory problems.

Aero Laboratory Cost Control

Research control that has due regard for the intangibles in aircraft production development, and also regard for the time factor, is capable of making estimates of the value of laboratory results and of operating productively according to a budget.

It is believed by some specialists that a *docket system* of research control enables the laboratory director to evaluate with most certainty the cost of the work entrusted to him and his staff, and to ascertain a capacity load for the latter. This procedure also gives him the means to fix responsibility if changes are made in any of the projects under the docket. Such a system has been very successfully used in the Mellon Institute.[1,2]

A skeleton form for projects under a research docket and also a form for a time sheet for use in determining monthly costs of researches are given in Donald's very useful *Handbook of Business Administration*. In employing the monthly time sheet, as described therein by R. G. Awell, each research laboratory employee records his own distribution of his time to the projects on which he has been assigned to work. By its use there can be calculated the distribution of salary to the projects.

Other items of expense, except supplies and special equipment which are charged to some specific tests, are generally prorated to the respective projects in the same ratio that salary charged monthly to a particular project bears to the total laboratory salaries. Among these items are cleaning, light, heat, power, steam, water, insurance, and depreciation. The depreciation rate of laboratory equipment is generally given as 10%.[1,2]

"LADDER" OF AVIATION JOB PROGRESSION

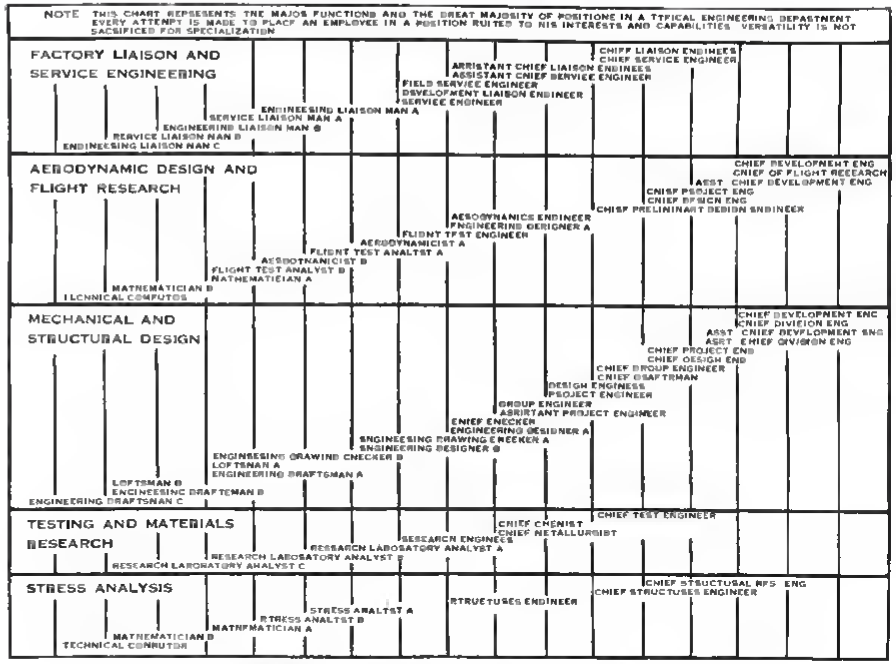


Fig. 1. Personnel represents prime cost of aviation research. This Convair chart indicates "rungs" in the job "ladder"

The *case system* of research control, used with success by Arthur D. Little, Inc., has been outlined by E. P. Stevenson. In this procedure, daily reports on special cards are said to afford a satisfactory means of recording the distribution of hours of working time of the laboratory staff. The accounting department then converts this time into dollars and cents, and these figures are followed in budgeting the time of the staff for the next month. A system of this type evidently has additional utility, for it enables the easy keeping of an accumulative record illustrative of the progress of tests in hand, and it makes possible the comparison of research project costs.[1,2]

The system used in cost analysis of development and research projects in the Engineering Test Laboratories of the Consolidated Vultee Aircraft Corp. at San Diego, is a combination of the "docket" and "case" systems, simplified to apply to aviation needs. Sections of the accounting department do this cost accounting for the Laboratories in man- hour collection of both engineering and shop time against test numbers. The test number, assigned to each test or development request as it enters the Laboratories, becomes the controlling medium (through simplified paper work to be discussed in a later part of this series) until the project is completed by the test report circulation to the requesting agency.

With the closure of each project the actual time expended by engineering and shop personnel is collected and compared with the estimated time allocation. Only by frequent checks of estimated against actual time expenditures can the test project engineers correct "poor guesses" and be educated for more accurate future "guestimates".

The expenditures for research or development in a large laboratory enmprise the salaries and expenses of executives, office, library, shop, storeroom, and building operation and maintenance; salaries of research men and assistants; supplies and house charges, which will include as well special charges for shop and office work; and traveling expenses incurred during business trips and during the attendance of members of the laboratory staff at appropriate scientific meetings.

Salaries in Aviation Research

Prior to World War II, a man who chose to become a scientific investigator or test engineer by profession was expected to be prepared to sacrifice, in the interest of his scientific work, a certain amount of material prosperity as compared with that which he would probably be able to attain if he entered such other professions as the law and medicine.

With the increasing number of laboratories, the competition for capable workers and administrators is producing a considerable increase in the wage scales and it is not too much to expect

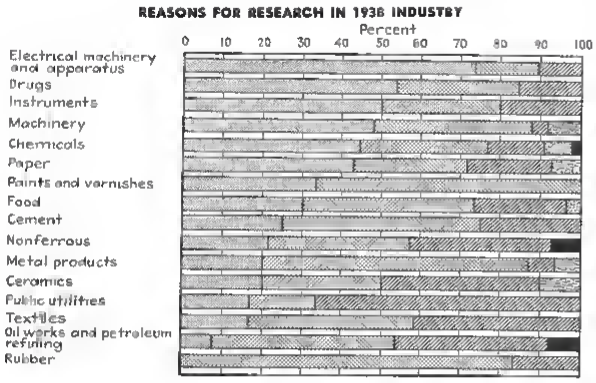


Fig. 2. This chart represents distribution of specific projects for industrial research in 16 industries (WPA, National Research Project photo)

that in the next few years, despite the probable aviation cutbacks, scientific research will be a well paid profession which will be attractive even to those who esteem financial rewards above all other considerations

A point which frequently arises in connection with the pay scale of men engaged in research is the method of remuneration Should research men and test engineers receive a straight salary, or should they be entitled to an interest in the profits arising from their work? The judgment of most men directing large laboratories is definitely against any system of payment by results On the whole, the best plan, according to Dr Kenneth Mees,[11] of the Eastman Kodak Research Lab, is to pay men a fixed salary, advancing their salaries in proportion to the quality of their work, whether or not that work results in direct financial gain

Initial salaries of test and research men and women will depend upon the person's educational background, previous experience, practicality, his publications and patents, and the importance of the problems being assigned to him

The laboratory job classifications, requirements, etc, in the aviation industry will be more fully discussed in a future article However, a few comparisons may be made Rates of pay for specific jobs may differ throughout the nation, depending upon availability of trained personnel, costs of living, status of local housing, etc However, the more common job classifications and salary ranges in the aviation testing and research laboratories are approximately as follows:

AVIATION LABORATORIES JOB CLASSIFICATIONS AND SALARIES

Classification	Hourly Rate*	Total Monthly Salary[12]
Technical		
Tech Computer "A"	$ 85–1 00	$191–228
Res. Lab Analyst "C"	90–1 09	201 237
Eng'ing Asst. "A"	1 00–1 15	225–260
Res. Lab. Analyst "B"	1 10–1 30	248–293
Res. Lab. Analyst "A"	Flat	285–455
Res. Engineer	Flat	410–560
Clerical		
File Clerk	75– 80	180–180
Depart. Clerk "C"	80– 90	180–203
Depart. Clerk "A"	90–1 05	203–237
Engine Tech "A"	1 05–1 25	237–282
Typist "A"	75– 80	180–180
Stenographer "A"	80–1 00	191 225
Secretary "A"	1 00–1 15	226–259
Library Attend. "A"	90–1 05	203–237

*Hourly rate based on a 40-hr week. Normal 46-hr weeks paid for with 1.5 x time for final 6 hr
**Total salary based on 36-hr week, with 1.3 overtime factor included. Flat* alary does not pay overtime rates.

The education, experience, and job requirements of each of the above types of work found in most aviation laboratories will be examined in detail in a future article on laboratory personnel training Other than the technical and clerical laboratory positions listed above, there are a few supervisory jobs —such as test group engineer, chief chemist, chief metallurgist, and chief test engineer—to be considered in completing the laboratory budget Since the salary ranges of these administrative positions vary between companies in the aviation industry and more radically in other research laboratories, no attempt will be made here to define their salary limits.

The positions available through the U. S. Civil Service Commission and affiliated with laboratory work may be of interest. These jobs, underpaid when judged by the present overinflated salary scales in industry, will again be in demand with the cessation of hostilities and the reduction in industrial staffs.

The relatively lower pay of certain Civil Service positions is more than compensated, in many cases, by the continuity and security of employment in periods of depression The postwar years will undoubtedly see this cycle repeated A few of the more common positions now open in Civil Service as War Service appointments, and which may offer postwar laboratory security to some now engaged in industry, are as follows:

Position	Basic Annual Salary (40 hr wk)	Present Annual Salary With Overtime (48 hr wk)
Technical		
Admin. & Exec. Off	$4 600–$5 600	$5 228–$6 328
Engineer, Asst. (P-2)	2 600	
Engineer, Assoc. (P-3)	3 200	
Engineer (P-4)	3 800	
Engineer Sr (P-5)	4 600	
Engineer-Princ. (P-6)	5 600	
Engineer Head (P-7)	5 600	
Engineer-Chief (P-8)	5 600	
Metallurg. (P 1 to P-5)	3 000– 5 600	2 433 6 228
Engineering Aid (SP-3 to SP-5)	1 440– 2 600	1 782– 3 163
Tech & Scient. Aid	1 440– 2 600	1 752– 3 163
Engineering Draftsman (SP-3 to SP-6)	1 440– 2 600	1 752– 3,163
Jr. Prof'al Asst	2 600	2 433
Clerical		
Princ. Cl'k (CAF-6)		2 797
Clerk		2 189
Jr Clerk		1 752
Stenog.		1 752– 1 970
Typist		1 576– 1 970
Librarian (P-4)	2 600	2 433
Library Asst (SP-5)	1 800	2 189
Shop		
Exper. Lab. Mechanics Aircraft & Eng. Mech.		2 433– 3,828
Gen'l Mech		2 189– 3 163
Instr. Maker		2 433– 3,163
Metalsmith		2 189– 3 828
Electrician		2 752– 3 163
Machinist		2 433– 2 163
Welder (Comb.)		2 713– 3 163
Woodworker & Carp.		2,433– 2 713

In contrast to the above rates of pay, the statements made in 1936 by Weidlein and Hamor in their helpful book *Glances at Industrial Research*[1-a] may be more indicative of possible postwar salaries "With no training other than that of the university, the suggested minimum entrance salaries for the first year, according to highest degree held, are as follows: B S $1,500, M S $1,800, and Ph D $2,400

"It has sometimes been well stipulated that, in the event of substantial progress being shown, these beginning salaries will be increased at the end of six months to $1,800, $2,100, and $3,000, respectively By this arrangement a probationary period will be provided for, and the self-respect and professional attitude of the man worthily stimulated

"When the candidate possesses additional professional training, the conditions of his employment become competitive. In general, however, the salary should be comparable with that of men of equal experience already in the laboratory Even in this case, a probationary period of service is highly desirable Salary advancement is necessary for its psychological effect, but must be judiciously administered for the same reason A wise policy will provide for reasonable increases based on merit, at predetermined intervals if possible, seconded by family considerations"[1-a]

Such research institutions as the Mellon Institute have found that, with few exceptions, the salaries of the research men amount to about 60% of the gross cost of each industrial research project.

Job Distribution in Aero Laboratories

Probably the most rapid method of preparing an annual budget in an aviation research laboratory is to provide a lump sum for the salaries of the personnel employed, plus a contingency item, to cover materials, equipment, etc, and then to reappropriate for major items as they arise Thus, were one to know the number of each classification of employee in a given laboratory, the yearly expense of the laboratory could be quickly computed within an accuracy of ± 15%. Breakdown of all projects on the books at the end of the fiscal year and reapportionment of time to each for the new year, with allowances for new projects arising during the year, might not be much more accurate than the above ± 15%

Let us therefore look at several aviation research, development, and testing laboratories of primary aircraft manufacturers for clues of personnel distribution. Three cases will be presented —"A", "B", and "C"—as indicative of the vast difference that exists in three laboratories doing approximately the same type of work

Laboratory "A"
(Approx. 60% Applied Research)

Research Engineers	8
Research Laboratory Analyst "A"	13
Research Laboratory Analyst "B"	32
Research Laboratory Analyst "C"	45
Clerical classifications	6
Total	109 personnel

Note Shopmen and planners attached to the laboratory were rated as Research Laboratory Analyst "B" and "C"

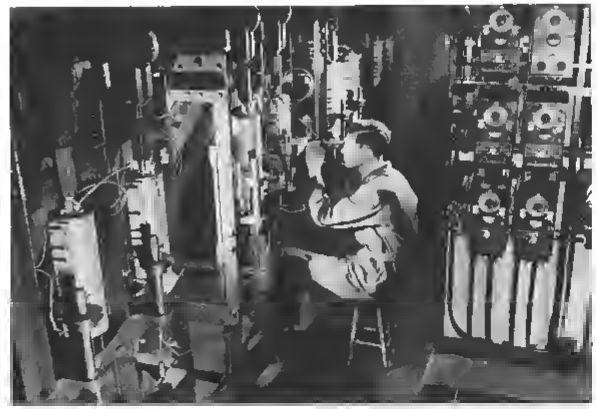
Laboratory "B"
(Approx. 20% Applied Research)

Research Group Engineers	6
Research Engineers	25
Research Laboratory Analyst "A"	13
Research Laboratory Analyst "B"	30
Research Laboratory Analyst "C"	4
Engineering Draftsman "A"	9
Engineering Draftsman "B"	8
Planners	25
Shopmen (+ 5 key leadmen)	130
Clerical classifications	20

Laboratory "C"

Work Distribution	Number of Projects	Percent of Total
Routine lab control, shop proc., raw material	24	11%
Misc. new material invest	77	37
Struct'l & strength tests	24	11
Operat'l & funct'l tests	53	24
Development tests	29	9
Research tests	18	8
Totals	210	100%

Personnel Distribution		
Chief Test Engineer	1	
Chief Metallurgist	1	
Chief Chemist	1	
Group Engineers	2	
Assistant Group Engineers	3	
Research Engineer	1	
Research Lab Analyst "A"	23	
Research Lab Analyst "B"	23	
Research Lab Analyst "C"	11	
Technical Computer "A"	1	
Engineering Technician "A	3	
Secretary "A"	1	
Library Attendant "A"		
Department Clerk "A"	1	
Total, Eng'rs & Clerical	75	
Shopmen in Exper Dept.	25	
Total Eng'rs, Cler., & Shopmen	100	



Making creep tests for determining high temperature properties of steel. This scene in Battelle Institute indicates elaborate equipment sometimes necessary to carry on research. Many laboratories operate on budgets to make specialized test equipment. (Battelle photo)

It is interesting to note the difference in personnel distribution, individual work loading, and percentage of applied research tests to total projects of these three aviation laboratories Still greater differences undoubtedly exist when comparisons are made between so called "applied research" aviation laboratories and the "basic research" laboratories of the automotive industry and in several of the research foundations

Some interesting facts are known about Laboratory "C" itemized above Of the 75 engineers and clerical personnel, approximately 20 or 27 percent are women, mostly college trained with science majors This particular laboratory was divided into eight distinct component parts, each specializing in specific fields as follows:

	Personnel	Percent of Personnel
Structure Tests & Res.	16	15%
Metallurg. Tests & Res.	3	0
Electric, Vibration, & Sound Tests & Res.	19	19
Chem. Tests & Res.	7	7
Physics, Spectrography, & Materials Tests	0	2
Mech. Tests & Res. (Hydraul., Pressure, Refrig., Tests, etc.)	7	7
Clss. (?) & Top Supers. (2)	3	2
Shop Pers. (Exper Dept.)	25	25
Tots Personnel	100	100%

If the engineering personnel in this laboratory, who contributed to the preparation of test and research reports, were to be separated from the shop, clerical, supervisory routine testing, and report coordination personnel, it would be noticed that approximately 47 engineers, metallurgists, and chemists carry approximately 200 of the 216 projects, or average over four projects per person at all times This personnel work-loading varies with the experience and competence of the individual, from one in new Research Laboratory Analyst "C"'s to as many as eight projects in the case of several of the senior R L A "A"'s.

It is obvious from the above comparisons of laboratory personnel, work loading, and classification that the "postwar" budget of aviation laboratories is an unknown factor, since the present importance of high-speed production will then give place to more development and reseach projects (it is hoped!), with the inevitable desire of "top management" to "economize" in all departments.

To many of those people most familiar with research laboratories and their importance in tomorrow's world, this attempted "economy" in research budgets may well cause considerable thought and discussion Possibly the postwar position of research in each company should be decided *today* when calm reasoning is possible, and *not tomorrow* in the excitement of victory

parades, curtailment of contracts, and postwar competition.

A Wise Postwar Research Economy

Realization of the importance of continuing aeronautical research after the war is apparent in the aircraft industry. Most aircraft companies, if the government leaves them with sufficient funds after contract terminations, contemplate sizable investments in research development departments to make best use of findings unearthed by private and government agencies, such as the NACA, Wright Field, The Bureau of Standards, and the Naval Aircraft Factory.

But what will the individual aviation company be building one year, two years, or five years from today? What are the commercial aviation possibilities? How many planes will our government services need in early postwar years? What will be the commercial transport requirements, and how many planes will be called for by private owners?

Probably as good a guess as any was that recently published by Wm A M Burden in the *Harvard Business Review*.[VI-9] The probable magnitude of the postwar aircraft orders is shown in the following table from that publication:

POSSIBLE ANNUAL SALES OF U. S. AIRCRAFT INDUSTRY IN NEAR TERM POSTWAR YEARS

Type	Number Planes	Value Each ($000)	Totals ($000)
U. S. Mil.	5,000	$200	$1,000,000
U. S. Trans.			
Domestic 50 Pass.	200	400	100,000
20-30 Pass.	100	90	10,000
nternat. 40-50 Pass	40	500	20,000
U. S. Private	50,000	2	100,000
Exports			40,000
Total			$1,270,000

If Burden[VI-9] is correct, it would appear that the majority of the aircraft manufacturers will be contractors to the Army and Navy. This probably being the case for early postwar years, it would appear desirable to consider the place of research and testing in the new contracts.

Much of the development and research work that has been done to bring out advanced types of planes in the last ten years has been carried out in addition to, or in spite of, the formal contract. Structural testing of aircraft components is—most assuredly—a part of every service contract, but much development and research has to be done that is not written into contracts. Why should research on these new planes not be emphasized and "incentive contracts" written to cover this important phase of aircraft production?

It is interesting to note that increased interest is being shown by the U. S. Navy Department in so-called "incentive contracts", incorporating specific expenditures for prototype testing and research, and it is considered probable that the Navy, and possibly the Army, will extend the use of such contracts in future dealings with aircraft manufacturers and with others producing for the Services in the early postwar years. Some executives of companies that have operated under this plan believe that it is better than cost-plus-fixed-fee plans, and also better than fixed-price contracts under wartime conditions, in that financial risks are more nearly eliminated.

Leeway for Research

Under the incentive-contract plan, the Navy and contractor agree on the basic cost of an item plus 10 percent profit. It is believed by the writer that the basic prototype-plane costs should include generous allowances for the development and research tests always necessary on new planes and that this research expense should not be deducted from the contractor's just profits.

For example. With the basic cost of a bomber prototype, including the necessary research on structures, etc., set at $1,000,000, the cost-plus-ordinary-profit would be $1,100,000. The contractor is then given additional latitude for unforeseen expenses, which might rise the total, say to $1,300,000. With completion of the contract, the contractor would have to support any costs between $1,100,000 and $1,300,000, the top price he would receive for the plane. He could receive $1,300,000, but no more. And if the cost was $1,290,000 his profit would be only $10,000.

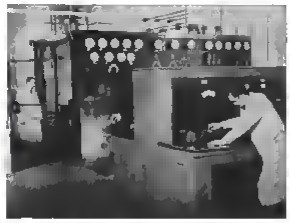
On the other hand, if production costs were reduced to, say, $980,000 the contractor would receive not only the original 10% profit agreed upon but in addition a percentage of the difference between $1,100,000 and $980,000, with consequent saving to the government.

It is encouraging to note that some thought is being given to aviation futures by such groups as the Woodrum Postwar Military Policy Committee, by several Aircraft War Production Committees, by an NACA group, and by a few scattered companies and individuals. Maj. Gen. Oliver P. Echols, assistant chief of air staff, material and services, recently told the Woodrum Postwar Committee that it is of the utmost importance that the aircraft manufacturers maintain relatively large and competent engineering staffs and that these engineers should be kept constantly at work on the development of new designs of aircraft and accessories.

The AAF officer did not elaborate on present or postwar plans for maintaining engineering staffs of the aircraft industry—which was hampered in prewar years because it was not permitted to assign engineering, development, and research test costs to service airplanes—other than to say that research and development did not depend so much on facilities as it did on the money made available to utilize these facilities.

While the text of these specific financial-problem articles can do no more than touch upon the many phases that exist of laboratory finance and budgets, it is sincerely hoped by the writer that sufficient controversial points have been suggested to inspire constructive criticism and good-natured arguments—we hope in the form of more such articles by others—all for the better understanding and closer cooperation among those entering the promising postwar period of aviation research.

(To be continued in later issues)



Switch panels in Chrysler laboratories. Comprehensive operating panels key the precise work in well-equipped and well maintained research rooms. Heats, specific bedgeting is dedicated for this and other primary equipment. (Chrysler Laboratories photo)

References to Part VII

For those researchers who wish to study further, the following references are offered. (Note: Articles once referenced in any part of this series will be referred to both by part number and by reference number, i.e. (II-6) indicates Part II Reference 6.

(VII-1) *Applied Research* by Dr. Harry R. Ricardo, F.R.S. from Presidential Address to Institution of Mechanical Engineers, London, Oct. 20, 1944.

(VII-2) *Postwar Gains of the Aircraft Industry* by Wm. A. M. Burden, *Harvard Business Review*, Winter, 1945.

(VII-3) *Industrial Research Expenditures* by Karl T. Compton, Section II-8 of *Research—A National Resource*, II *Industrial Research*, Dec. 1940.

(VII-4) *DuPont Research* by Dr. E. K. Bolton, an address before American Section of Society of Chemical Industry, New York City, Jan. 9, 1945.

(VII-5) *Research Makes Jobs*, by Dr. Cole Coolidge, E. I. duPont de Nemours Co., an address before *N. Y. Herald Tribune* Forum.

(VII-6) *Pennsylvania Salt Manufacturing Co. and Research*, Pamphlet by Penn Salt Mfg. Co. (Whitemarsh Research Labs. Philadelphia, Pa.). 1944.

AERO COMMANDER IS NEW LIGHT TRANSPORT

As soon as materials are released, Aero Design & Engineering Corp. will build two-engine five-six place craft of all-metal design with tricycle landing gear. Price is ranged at $12,500 and up, according to equipment and furnishings.

CONSTRUCTION OF A NEW executive-charter-feederline plane is now projected by the recently formed Aero Design & Engineering Corp., Culver City, Calif., and production of the prototype is expected as soon as the "makings" are available.

Now in the mockup stage, the craft has been designated the Aero Commander L-3804 and is to be a cantilever high wing monoplane powered by two 190 hp. Lycoming six-cylinder engines. Designed to seat a pilot and four passengers, there is also to be enough space for a sixth seat if regulations permit. Seats could be removed for conversion to cargo service. The Aero Commander is expected to sell for $12,500 and up, depending on interior furnishings and equipment specified by buyers.

It is stated that the craft will have a top speed of 181 mph. at sea level, while on one engine maximum speed would be 135 mph. At 75% of rated power, operating speed is to be 165 mph. Stalling speed at sea level with flaps up would be 64 mph., and with flaps down, 57 mph. Speed for maximum L/D is estimated at 89 mph. and maximum L/D with flaps up at 122.

The Aero Commander's service ceiling would be 24,400 ft., and on one engine the craft's ceiling is put at 11,500 ft. Rate of climb at sea level, it is stated, will be 1,740 ft. the first minute. The endurance at operating speed is to be 3.8 hr., with 80 gal. fuel capacity, or a range of 700 mi.

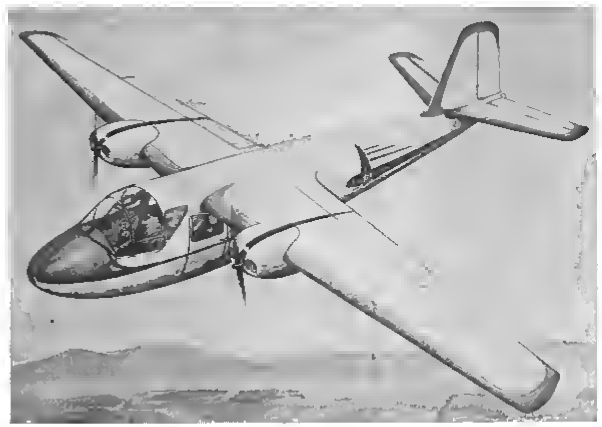
Performance figures include a run of 1,350 ft. to clear a 50 ft. obstacle, and landing distance to a stop, after clearing a similar obstacle, is estimated at 850 ft.

Gross weight of the craft would be 4,200 lb., and it would weigh 2,500 lb. empty. Called for is a wingspan of 43 ft. 10 in., an over-all length of 32 ft., and maximum height of 10 ft. 4½ in.

An NACA 23012 airfoil will be utilized for the wings at both root and tip. Area will be 240 sq. ft. with flaps retracted, and including ailerons and tab which will have a combined area of 20.8 sq. ft. Root chord is given as 100 in. and tip chord as 33 in. Taper ratio is to be .33 and incidence at tip 2 deg. Dihedral is to be 4 deg., and aspect ratio of 8.16 will be used. M.A.C. will be 72.122 and M.A.C. location relative to leading edge of root chord is to be 110.26 horizontal and plus 6 in. vertical. Flap area will be 31.5 sq. ft. and flap mean chord 19.7 in. Maximum angular deflection is to be 45 deg., and aileron angular deflection will be 30 deg. up and 20 deg. down. A differential motion of 1.5:1 is planned.

Wing is to be a full-cantilever semi-monocoque two-spar aluminum alloy structure, built in four main parts—left and right panels (extending from the fuselage center line to within 8 in. of the tips) and left and right wing tips. Ribs will be aluminum alloy with aluminum alloy extruded sections running spanwise with aluminum alloy sheet covering. All surfaces forward of the spar are to be flush riveted. Main panels are to be joined to the fuselage by aluminum alloy fittings and steel bolts. Wing tips are to be attached using completely recessed flat head machine screws and self-retaining-nut plates.

Ailerons will be built up on one spar with fabric covered aluminum ribs. Aerodynamic and static balances are



Sketch of projected five-six place Aero Commander L-3804 light transport which is now in mockup stage. Company states that construction of a prototype will begin as soon as materials are released. Craft is to be powered by two 190-hp. Lycoming engines, and top speed is estimated at 181 mph. at sea level. A cruising range of 700 mi. is planned.

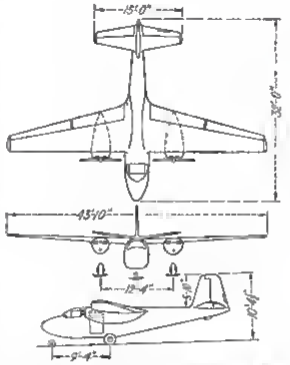
to be provided integral with the ailerons at the extreme tips. A trim tab in the left aileron is to be adjustable from the ground.

Horizontal tail surfaces, including fuselage, are to have a 15 ft. 4 in. span, 57 in. maximum chord, and will contain 51.25 sq. ft. of area. The horizontal stabilizer is to have a total area of 23.25 sq. ft., and the elevator 18 sq. ft. Elevator tab area will be 72 sq. in. Vertical stabilizer including fairing, will have an area of 16.06 sq. ft., and rudder including tabs will have 13.1 sq. ft. of area. Rudder tab area will be 48 sq. in.

Planned for the horizontal stabilizer is full-cantilever all-metal one-piece construction, with 10 deg. dihedral to elevate stabilizer tips above the wake of the wing and to provide added stability. Construction of the elevator will be similar to that of the ailerons. The vertical fin will also be made in one piece, full cantilever, and all-metal, and it will be fitted to the fuselage by means of tension bolts. The rudder is to have an all-metal framework covered with fabric.

The semi-monocoque fuselage is to have a maximum cross section height of 64 in., a maximum width of 54 in., and is to be of all-metal construction. Channel-type frames, spaced about 26 in. apart, will support the metal skin, which will be stiffened longitudinally by extruded aluminum alloy sections.

Landing gear, to be of the completely retractable tricycle type, is to have main wheels mounted on single, braced oleo pneumatic struts conforming to specification ANC-1. Main wheels are to be the smooth contour, disk type, with hydraulic brakes actuated by toe pedals to be integral with the rudder pedals. They will retract aft into the engine nacelles. The nose wheel, also smooth contour, is to be mounted on a single oleo pneumatic shock absorber strut. It will be capable of swiveling up to 30 deg. each side of center and is to be fitted with a spring snubber. Retraction will be forward and up into the nose.



Three-view layout shows all cantilever design. Construction is to be all-metal, with exception of fabric-covered control surfaces. Tricycle landing gear is retractable, with main wheels swinging back into engine nacelles and nose wheel forward and up.

Fuel tanks, of the rubber bladder type, are to be located in the leading edges of the wings inboard of each engine. Individual fuel systems will incorporate gravity feed.

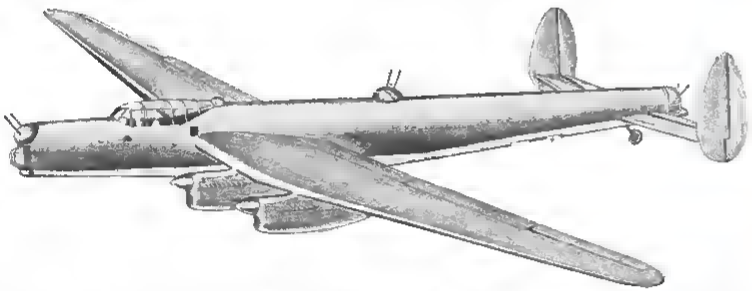
It is stated that commensurate with the weight involved, Sea Pack sound-proofing will be used. The baggage compartment, just aft of the rear passenger seat, is to accommodate four average size suitcases and will be accessible in flight.

Founders of Aero Design & Engineering Corp.—incorporated in Dec. 1944 in California with an authorized capitalization of $1,000,000—are a group of aero engineers connected with several of the Southern California airplane companies. President of the new company is T. R. Smith, who was formerly project engineer on the Douglas A-20 attack-bomber series, and Paul A. Leaman is secretary and treasurer.

Specifications and Data

Wingspan	42 ft. 10 in.
Length	32 ft.
Height	16 ft. 4¾ in.
Tread	12 ft. 4 in.
Wing area	240 sq. ft.
Gross weight	4,300 lb.
Empty weight	2,800 lb.
Top speed (sea level)	161 mph.
Cruising speed (sea level)	138 mph.
Stalling speed (sea level)	57 mph.
Climb (sea level)	1,745 fpm.
Service ceiling	24,400 ft.
Ceiling (one engine)	11,500 ft.
Range	700 mi.
Fuel capacity	60 gal.
Seats	5-6
Power plants	Two 190-hp. Lycoming 6-cyl.
Propellers	Two-blade automatic type, 6 ft. 6 in. dia.
Price	Est. $12,500 and up

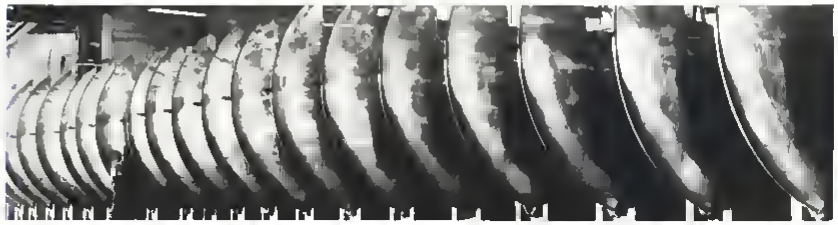
Avro Grooms Lincoln Super-Heavy For Stepped-Up Hammering of Jops



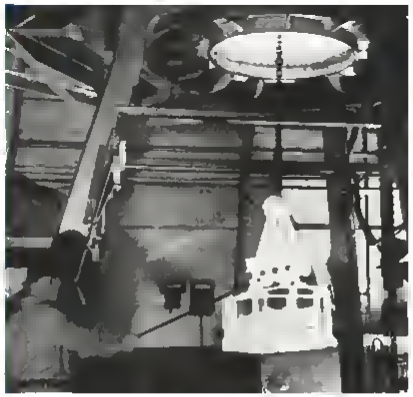
NEW BRITISH super bomber, Avro Lincoln, as conceived by AVIATION staff artist, indicates this new addition to Allied air power bears a great resemblance to famed Lancaster but is much bigger. Designed for Pacific operations, craft is in same category with Boeing's Superfortress and is reported powered by Rolls-Royce Merlin engines. Wingspan is believed to be about 120 ft. and gross weight between 100,000-125,000 lb. In comparison, Lancaster III has span of 102 ft. and grosses 60,000 lb. Publicized good flying qualities and load carrying ability of "Lanc" probably influenced continuance of basic design for Lincoln.

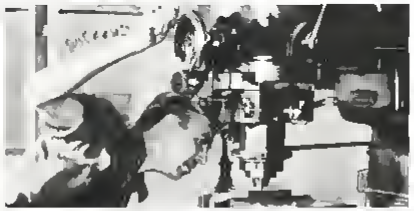
TO THE WORLD... *a Miracle*

TO CESSNA.... *a "Natural!"*

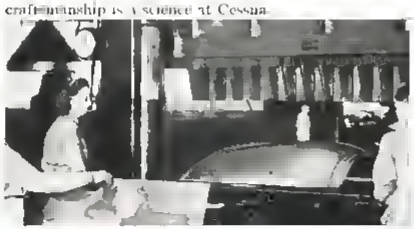


THE BOBCAT PRODUCTION LINE.....now builds heads for Douglas Invaders and tails for Boeing Superfortresses!





PRECISION machining parts to tolerances of 1/10,000 of an inch or forming engine cowlings on a 2500 ton press, metal craftsmanship is a science at Cessna.



HOT SPOT ... where metal parts of Superforts and Invaders are heated at 1700 degrees Fahrenheit

Thirty-four years of aircraftsmanship at Cessna is not just that many years of manufacturing airplanes. It is thirty-four years devoted to research, engineering, experiment and progress. What seemed to the world a miracle of transformation from peacetime private planes to all-out production of parts for giant B 29's was a natural accomplishment for Cessna.

When war came, the Cessna T 50, the famous twin-engine Bobcat, had already been acclaimed by America's private fliers. Its single-engined sister plane, the Cessna Airmaster had been three times proclaimed the world's most efficient airplane.

The Cessna production line swung over instantly to the task of turning out advanced trainers for our bomber pilots and those of our Allies. At peak production, Cessna planes were flying more than 2,000,000 training miles a day!

The training job completed, Cessna converted again . . . this time to building assemblies for the Douglas Invader and the Boeing Superfortress. Skilled in the craft of fabricating airplanes, Cessna's master workmen and women took this new job in their stride, turned out these vital war materials at top speed . . . and sharpened their tools and their skills for the peacetime job ahead.

Listen to "Science Looks Forward"—new series of talks by the great scientists of America—on the Philharmonic-Symphony Program CBS network, Sunday afternoon 3:00 to 4:30 E W T.

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue
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D. H. PUSHES CONSTRUCTION ON NEW DOVE FEEDERLINER

Bearieg a resemblaece to Masquito fighter-bomber, tricycle-gear all-metal light traesport is desigeed te accammadate eight te eleven passeegers. Aed it's ae all-D. H. product, siece compaey is supplyieg engiees aed propellers as well as airframe.

NOW UNDER CONSTRUCTION and scheduled to make its first flights sometime this year is the DH-104 Dove, a new feederline type transport by Britain's de Havilland Aircraft Co It is stated that the Dove will have first priority in the company's postwar commercial program hence production will begin as soon as conditions permit

A transport development of the famed D H Mosquito fighter-bomber, the Dove will be of all metal construction, with stressed skin covering, and it will feature a retractable tricycle landing gear Two supercharged D H Gipsyqueen six-cylinder in-line engines will be equipped with new type D H three blade constant-speed feathering propellers These airscrews will incorporate reversible pitch blades to aid in braking after landing

Since the new craft has been designed to serve small branch lines, charter traffic, executives and for personal pilots, various cabin interiors are planned It is stated that as a transport the ship will normally carry eight passengers and a crew of two with inclusion of lavatory accommodation fore and aft freight compartments dual controls and radio layout Other variations include seating for ten passengers without a lavatory, or eleven seats if the aft luggage compartment is also eliminated.

Normal range is to be about 500 mi and the craft will weigh about 8,000 lb loaded

This will be de Havilland's second all-metal transport, the first was the prewar Flamingo, which was somewhat similar to the Douglas DC-5 It is now being used by the RAF as a light transport

Specifications and Data

Span	67 ft. 10 in
Length	39 ft. 8 in
Height	12 ft. 6 in
Range	approx. 500-mi
Gross weight	approx. 8,000 lb
Passengers	8–11
Crew	2
Power	2 D H Gipsyqueen 6-cyl supercharged in-lines
Propellers	2 D H three-blade constant-speed feathering reversible pitch

Artist's conception of de Havilland Dove transport in flight shows craft's marked resemblance to Mosquito fighter-bomber New craft is to be of all metal construction with stressed skin covering, and power plants will be D.H. Gipsyqueen sixes fitted with D.H. three-bladed feathering and reversible pitch propellers A crew of two and from eight to eleven passengers are stated to be capacity

Featured on D/H. Dove will be a retractable tricycle landing gear Plane has been designed for use by feederlines, charter operators, executives, and also for personal pilots. Gross weight will be about 8,000-lb., and range approximately 500 mi. Planned are freight compartments fore and aft Prototype, now under construction, is expected to be flying some time this year

Grumman F7F Tigercat in flight gives an impression of pointed deadliness. Most powerful and heaviest armed fighter plane now in service, it has a stated top speed of well over 400 mph and cruising radius of 1,500 mi. Engines are P&W R-2800-C Double Wasp at 2,100 hp each equipped with water injection and ejector exhaust stacks. (Official U.S. Navy photo)

GRUMMAN'S TIGERCAT FIGHTER IS NEW JAP HEADACHE

In 425-mph. class, twin engine, tricycle landing gear F7F 'Cat is our Navy's largest, fastest single seater fighter—has mile-a-minute climb and packs two-ton bomb load, torpedo, or rockets. Now being flown by Marines, it may also be based on big new carriers.

OUR NAVY'S LATEST AND LARGEST fighter plane, the Grumman F7F Tigercat, is now in production for U. S. Navy and Marine air groups. Although the Marines have been getting initial Tigercat production these planes also may be operated by Navy fliers from the new 45,000-ton Midway class carriers now coming off the ways.

This big new fighter plane is a departure from previous naval types in several ways. It is our Navy's first twin-engined single seater fighter, and the first to have tricycle landing gear. It is the first combat type designed from the start to perform a combination of duties—as fighter, long range escort fighter, bomber, strafer, torpedo-bomber, and night fighter (F7F-2N).

Powered by two Pratt & Whitney R-2800-C Double Wasp engines at 2,100-hp. each, equipped with water injection ejector exhaust stacks, and Hamilton Standard three-bladed Hydromatic propellers, the Tigercat has a top speed in the 425-mph class, at craft's critical altitude. Rate of climb is stated to be a mile-a-minute, and with a 300-gal. drop fuel tank range is considerably greater than either the Corsair or Hellcat, both of which have a cruising radius of 1,500 mi.

Construction is all-metal with stressed skin covering and the dark blue camouflage finish is highly polished to bring skin drag down to a minimum.

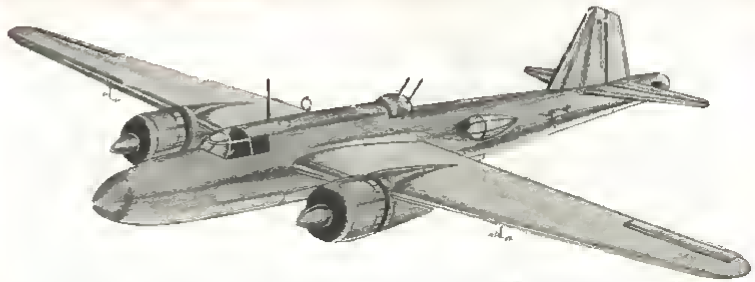
It is a big airplane, when compared with contemporary fighter craft, almost half again as heavy as the F6F Hellcat, which weighs about 7,000 lb. However, at a recent press preview where the plane's flying qualities were demonstrated by a group of Marines and by Grumman's test pilot, the craft showed a remarkable ease of maneuverability at a wide range of speeds.

Firepower of the F7F surpasses that of any naval fighter now in action. In addition to heavy standard fixed armament, 4,000-lb. of bombs, or a full-size naval torpedo can be carried, or rockets, or rockets and bombs.

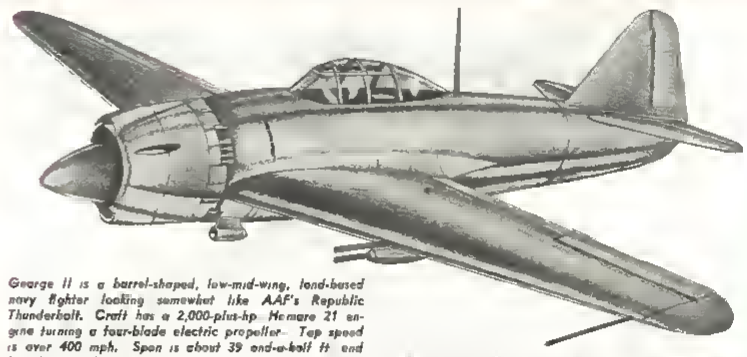
Tigercat's folding wings are hydraulically operated from cockpit. They are seen here in fully folded position and require no bracing bars. In leading edge of wing's center section are four air intakes, one on each side of each engine. (Photo by Aviation staff photographer)

NEW JAP WARPLANES

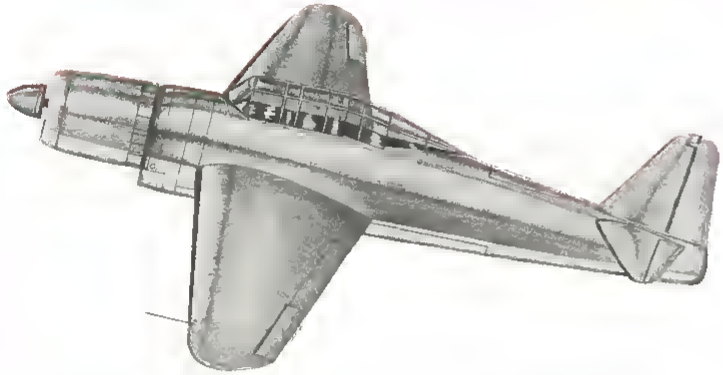
Exclusive AVIATION feature, with staff artist sketches, gives available data on recently spotted Nip military craft. Indications are that our remaining enemy is adept at combining some originality with better features of other nations' warcraft—and is turning out some very good equipment.



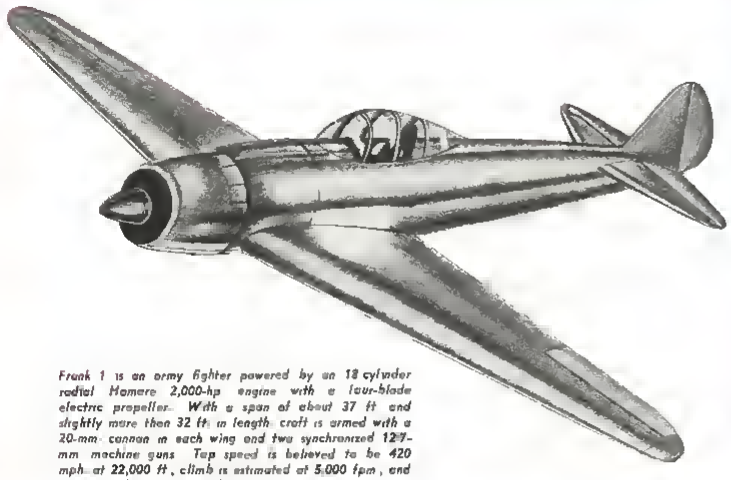
Peggy I is an army reconnoissance-bomber that looks very much like Betty and Helen. Powered by two unknown type radial engines, craft has full feathering propellers. Span is about 74 ft. and length about 61 ft. Top speed is approximately 345 mph. at 20,000 ft. There are at least two versions of this plane, one with a plywood-covered nose and tail cone, used for reconnoissance and search and fitted with radar, another type has conventional transparent nose and tail piece, for bombing operations. Craft has a hydraulically operated power turret with a 20-mm. cannon and waist blisters probably mounting machine guns.



George II is a barrel-shaped, low-mid-wing, land-based navy fighter looking somewhat like AAF's Republic Thunderbolt. Craft has a 2,000-plus-hp. Homare 21 engine turning a four-blade electric propeller. Top speed is over 400 mph. Span is about 39 and-a-half ft. and length is nearly 30 ft. Heavy armament consists of four 20-mm. cannon in wings and two 12.7-mm. nose machine guns. Engine is fitted with water injection device and has ejector type exhaust stacks. Japs call this plane "Shiden" (violet lightning). It may be type U. S. Navy pilots recently reported as giving them stiff opposition. Also reported in service is a single-float seaplane fighter version named Rex II.



Judy 33 is latest known model of standard Jap carrier-based dive bomber which previously used an Aichi Atsuta 1,150-hp in-line engine. New radial powerplant is a Mitsubishi Kinsei 62. Span is nearly 38 ft. and length is about 34 ft. Retractable spoiler type dive flaps are fitted to under surfaces of wings. Top speed is reported as just over 300 mph. Seating two, craft is lightly armed and is not believed to have self sealing tanks.



Frank 1 is an army fighter powered by an 18 cylinder radial Homare 2,000-hp engine with a four-blade electric propeller. With a span of about 37 ft. and slightly more than 32 ft. in length, craft is armed with a 20-mm. cannon in each wing and two synchronized 12.7-mm. machine guns. Top speed is believed to be 420 mph. at 22,000 ft., climb is estimated at 5,000 fpm., and service ceiling at 39,000 ft.

CIVIL OPERATIONS

For want of aero guideposts, flyers may be lost. And for want of flyers, the airport business may be lost. Answer lies in installation of a practical air marking system which will solve the landmark mysteries and make it easy to—

CHERCHEZ LA AIRPORT

By JOHN ABIUSO

A MUCH TRAVELED tourist once remarked, "When you've seen six mountains, you've seen them all because the rest will look the same" If he had been a touring flyer his remarks would have been even more emphatic because it is quite easy to mistake one whole county for another, particularly when passing over parts of the country where easily recognizable landmarks are scarce.

In fine weather, with plenty of fuel in the tank, this kind of thing is merely annoying but in rain or snow, inability to locate himself may cost a pilot his life.

Painted or concrete markers have often been used for the purpose of guiding flyers, as have signs on roofs of large buildings, but in snowy weather the painted ones are often obscured and the common concrete ones are buried by a heavy snowfall.

To obviate this defect the author has designed a new type of elevated marker sufficiently high to prevent either drifting snow or sand from covering it. In sections where undergrowth springs up rapidly, this type of marker may be erected to a height overtopping the surrounding scrub.

General views of the marker at different stages of snowfall are shown in Fig. 1, 2, and 3. In the first photo, the snow is up to the bottom of the flat portion, in the second, it has partly covered the lower part; while in the third stage the vertical part of the sign is the only part visible, yet in every case the marker is still clear and unmistakable. The slatted construction prevents even wet snow from drifting over the top of the vertical parts.

Fig. 1. Sign when snow is level with underside of horizontal slats. Patented construction enables marker to be seen even when snowfall has been heavy. Snow has been blown clear from flat surfaces.

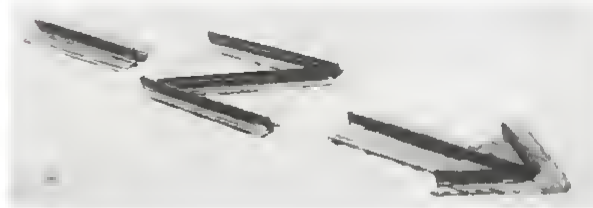


Fig. 2. Same sign after fresh snow has fallen on slatted horizontal surfaces. Vertical portions give good visibility.

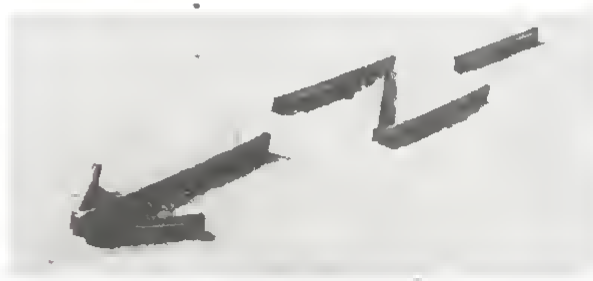
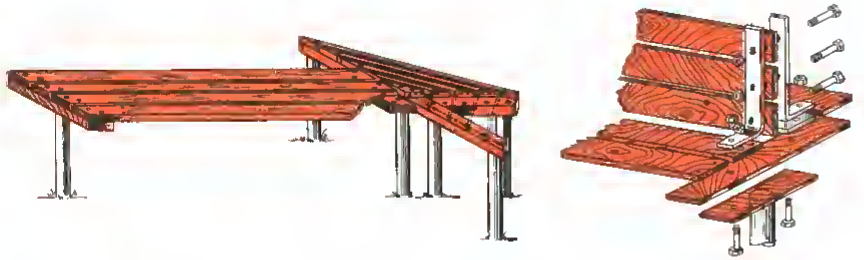


Fig. 3. After horizontal parts of sign have been entirely buried by snow this sign will stand out and be visible for a long distance. Slatted construction allows snow to blow through vertical parts of sign instead of drifting against them and rendering them invisible.



a condition which would render useless almost any other type of construction.

The building method, which is detailed in Fig. 4, is designed to permit unskilled help to erect these markers in a minimum of time and of stock materials. Except for sawing the ends to length and angle, and drilling a few bolt holes, no skill whatever is needed for putting the signs together.

Construction costs are kept low through use of 1 × 6 in. lumber for the slats and strap iron for the end braces. A marker consisting of an "N" and arrow pointing north would require about 44 pieces of 1 × 6 boards, 20 ft. long, plus about 6 doz. bolts with nuts and two washers each. Two dozen posts, long enough to project 3 to 3½ ft. above ground level would also be required. Total cost would approximate $28 at present prices, including sufficient paint for two coats.

For night lighting a series of electric lights may be attached along the top edge of the marker. These could be switched on by an attendant or by a photo electric cell, which latter plan has the advantage that any sudden overclouding would cause the sign to be lighted for the duration of the darkness.

To obtain maximum value from these devices, it would be necessary to employ them according to some universal system. CAA has already advanced the use of large signs, painted on roofs or marked on the ground, showing both the name of the town or airport and its direction. Unfortunately, these markers are infrequent, and those which are employed are not always in the places where they are of greatest value to the flyers.

It is not at all uncommon for a pilot to fly for several hours without seeing any kind of marker. In such cases he has to rely entirely upon the appearance of the country beneath him. If this trouble occurred on his first flight over that territory and the weather became a hazard, there would be likelihood of trouble.

Now, let us consider what conditions would be if a system of markers were used. These could be placed at block intervals of 20 mi. so that it would be impossible for a flyer to be more than, say, 14 mi. from a marker, and this only when he was in the very center of a block. If the pilot were confused as to his whereabouts, he could fly in a widening circle, then he would readily locate a marker.

It has been proposed by the CAA that distances of airports from markers, also compass readings giving flight direction, should be printed on the back or margin of the maps, thus saving much computation at a time when the pilot might be busy locating himself.

Author's proposed system would use markers as shown in Fig. 5. The arrow shows north and the letters and figures give the position. Upper figure and letter follow the system (now used on road maps) where the top and bottom are divided into numbered strips and the sides into similar sections distinguished by letters. The name of the state is given below the dividing line. For instance, in Fig. 5, the marker indicates that it is situated at the intersection of vertical strip No. 7 and horizontal strip Letter A in the state of Pennsylvania. By referring to the list of distances on the margin of the map, the pilot would find the distance and compass direction in degrees to the nearest airport.

Fig. 5. Marker arrow indicates north. "PA" shows that sign is in Pennsylvania, while position is intersection of strip 7 with strip A. Vertical portion of sign has not been attached.

Method devised by CAA is similar except that it uses latitude and longitude readings. This is excellent for the man who is familiar with the use of charts for plotting courses, but this method may be somewhat unwieldy for a new pilot who has served many years apprenticeship in road map reading.

Objection has been made to general use of markers on the score of high cost, but this is a fallacy. When benefits are balanced against cost of installation and upkeep, a national air marker system would be one of the cheapest forms of pilot life insurance ever proposed.

Let us take a specific state—Pennsylvania. It is neither the largest nor the smallest, having an area of about 45,000 sq. mi. To lay out the entire state would require less than 200 markers. Some states would require more, others less, but this is a good average. Each marker serves 20 × 20 mi., or 400 sq. mi. so that 7,500 markers would suffice to give coverage for the entire United States.

Built and shipped in quantities, markers would not cost over $20 per letter, in place, or a total of $600,000 for all 48 states. This is the cost of about 30 mi. of ordinary first class highway. As compared to the more than $97,000,000 of Federal road expenditures during a recent year, the cost of national air marking is about 1½ percent. No other movement of such national importance and benefit would cost so little.

In the event that the CAA proposed system, using latitude and longitude, were used, the cost would be doubled, due to the larger number of letters, but even then it would not be heavy, as national public works expenditures go.

As a comparative figure, the Federal Government expended in 1942 the sum of $19,500,000 for elimination of railroad grade crossing hazards, a sum sufficient to install markers throughout the country at less than 10 mi. intervals. So the question of cost cannot be considered as a valid objection.

The system advised by CAA is shown in Fig. 6, and both methods of marking are compared on the map presented in Fig. 7. Each has advantages and disadvantages not possessed by the other, but it is likely that the inexperienced flyer—that is, the average plane owner—would prefer reading four letters rather than eight, especially if he were attempting to locate himself on the map at the same time.

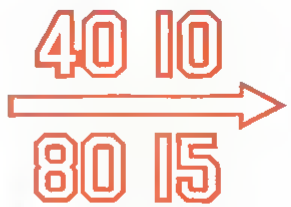


Fig. 6. Standard CAA marking shows latitude at top and longitude at bottom.

There are several advantages in using a marker which shows the name of the state over which the plane is traveling. First of all, because a pilot may fly from one of the smaller states to another without knowing it, if the weather is cloudy, it is a distinct advantage to him if he can make sure that he has to use another map rather than the one with which he started. Unless one is flying over fairly familiar territory, merely knowing latitude and longitude is no index to the map which should be used. There are several localities in this country where three or four states come together, or are so close that it is quite possible to pass over all of them in less than half an hour. Since state lines are not marked for indentification from the air, some means is required whereby the pilot may make sure that he really is flying where he believes he is.

In addition, markers which carry state identification have a great advertising value. They serve as a constant reminder to the flyer that he is passing over a district where there may be places of interest worth stopping to visit. Resulting extra business should more than pay for the cost of the sign within a short time.

Though the preceding description has been written on the assumption that the markers would be built of lumber, many other materials might be used. One large steel manufacturer already has been experimenting with enameled steel for this type of sign, and this firm appears satisfied with the results. Advantages of prefabricated units would be in cheapness of erection, but against this factor would be a much higher freight rate for the units and the cost of protective packing, both greater than in the case of lumber. A well painted lumber sign, properly maintained, should last as long as a well painted building of the same material. There are hundreds of centenarian houses made of lumber—houses still in excellent condition—so the obsolescence of the wooden sign should not be a matter of material so much as a matter of care expended in its maintenance.

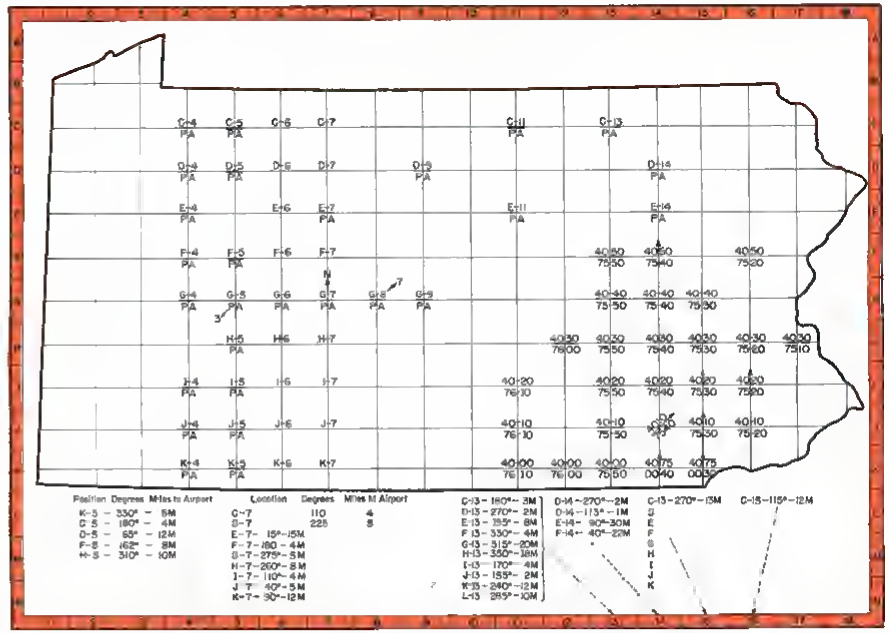


Fig. 7. Map of Pennsylvania with CAA markings system at right and author's proposed system at left. Specimens of directional figures are given at top of map, showing distances to nearest airports from different intersection markers.

INSPECTION AND SERVICING OF AEROMATIC PROPELLER

PART I

Detailed here in picture form are steps for efficient checking and maintenance of Koppers Co. automatic propeller designed for small and medium-size aircraft.

THE AEROMATIC PROPELLER, made by the Koppers Co., Bartlett Hayward Div., Baltimore, adjusts its blade pitch automatically through reactions caused by centrifugal forces and propeller thrust.

Since each throttle setting or change in manifold pressure causes a different thrust, and because the centrifugal forces, which tend to turn the blade, vary with the rpm., each combination of these forces results in a slightly different position of the blades. In other words, operation of this airscrew is via varying forces which are always present during flight, instead of by mechanical pitch-changing means.

Time lag is extremely small because no governor reaction is necessary prior to direct action on the blades.

Maintenance and replacements have been kept to a minimum through the simplicity of the design, which required only one major moving part besides the blades. Since the forces causing change of pitch are restricted by the weight and rpm. of the propeller, it is essential that lubrication, clearances, and adjustments be given close attention. When these factors are cared for, satisfactory action in flight is automatic.

(Turn page for illustrative figures)

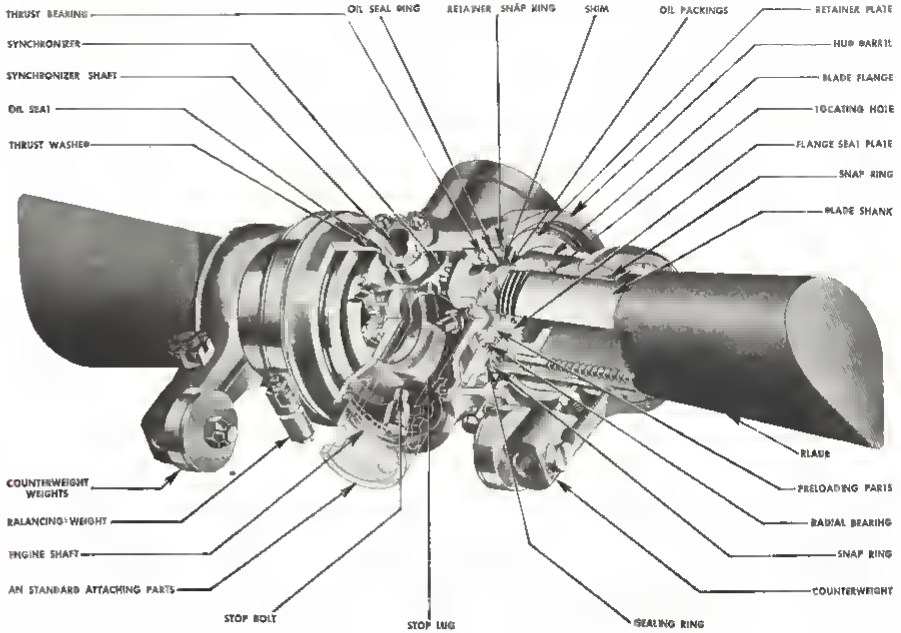


Fig. 1. Cutaway front view of Aeromatic propeller shows simplicity of construction

Fig. 2. Front view shows 20-spline hub and offset blades covered with plastic sheet. Blades are built of thin laminations and tipping is metal.

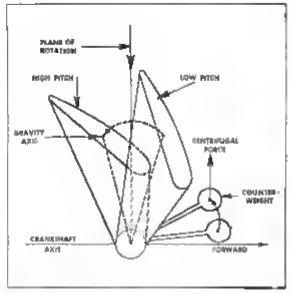


Fig. 4. Forces acting to move blade. Centrifugal force of blade tends to move it into line with plane of rotation. Thrust against working face would push blade forwards into low pitch. Counterweight tends to move blade into high pitch position. Balance between these three forces results in blade moving to correct pitch for each combination of forces. Changing of position of counterweights at assembly will result in changed pitch for same working conditions.

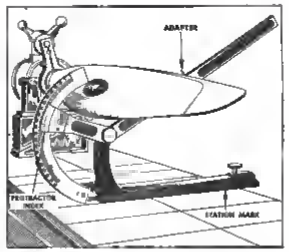


Fig. 7. Phase angle is measured at 36 in. radius station, with adapter between blade and protractor. A magnifying glass should be used for this work, reading being taken in tenths of a degree.

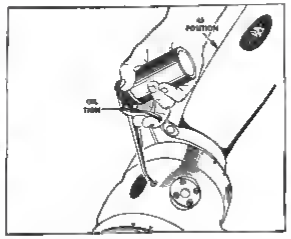


Fig. 5. Oil check is made with blade at 45 deg., after which hub is filled to point where oil is level with edge of hole. Plug is lock-wired when replaced.

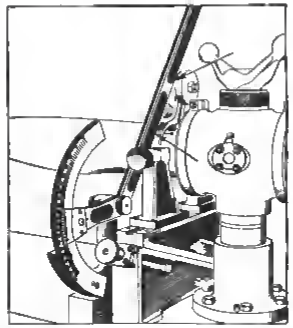


Fig. 8. Counterweight angle is measured from leading edge of prop, with protractor touching flat surfaces shown by arrows. Reading is in tenths of a degree. When this and previous reading are completed on No. 1 blade, process should be repeated on opposite blade. Then assembly fork should be removed and angles measured with blades against high and low pitch tops, respectively. Blade should be supported in low pitch position by means of padded blocks.

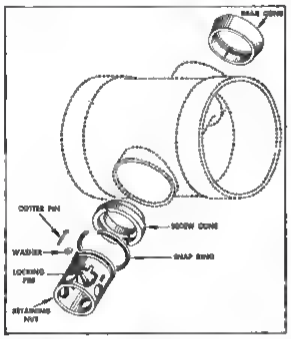


Fig. 3. AN standard attaching parts consist of rear cone, AN5008-20; front cone, AN-5007-20, retaining nut, AN5011-20; snap ring, AN5009-20; flat head pins, AN394-18, plain washer, AN960-416; and cotter pin, AN-380C-2-3. Parts are placed on shaft in order named, with prop between cones. Surfaces are to be covered with anti-seize, AN-C-53, or mixture of 70% white lead in 30 percent engine oil.

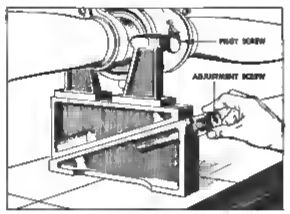


Fig. 6. Assembly fork is placed under No. 1 blade and raised until pilot screws line up with holes in flange, into which screws are turned. Adjustment screw should not be too tight or it will affect blade alignment. Work is done with propeller on arbor of protractor table. Great care should be exercised to insure that assembly fork screws enter holes in blade without fouling sides which would cause misalignment of blade.

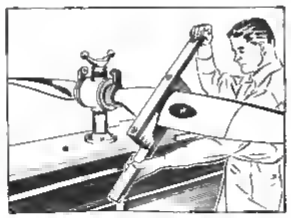


Fig. 9. To remove blade withdraw cotter pin and counterweight clamp bolt. Then take out counterweight lockscrew and unscrew blade in counterclockwise direction, using padded blade wrench, as shown. Mark all parts so that they may be re-assembled into same blade.

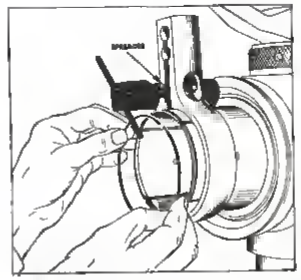


Fig. 10. Removal of counterweight is accomplished by sliding it back far enough to permit removal of snap ring in end of flange after which weight may be slipped off. Spreader may be used if weight is tight.

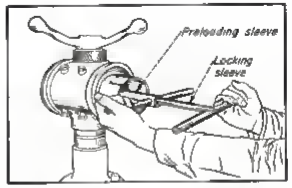
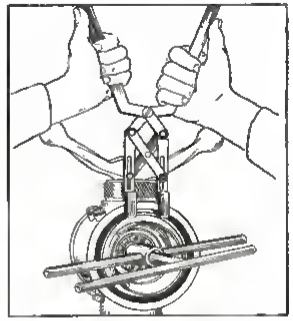


Fig. 12 (above) and Fig. 13 (right): Insert preloading tool (which has a toothed tubular outer part to fit preloader sleeve and hexagon center piece for Allen pipe plug which expands and locks sleeve) through clamps and loosen pipe plug while holding sleeve from turning. Turn preload sleeve all way in and remove snap ring with tool (Fig. 13). Keep oil pan under barrel at this time. Count and remove shims along with packing retainer, oil seal retaining ring and oil packings. Remove oil seal ring first to prevent damage. Remove flange and thrust bearing.



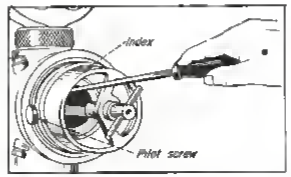


Fig. 11. Flange seal plate retains oil in hub, therefore a receptacle should be employed to catch oil before removing plate. To take out plate, install flange seal ring assembly tool on flange, with index marks on top, and secure pilot screws in flange-locating holes. Turn handle until plate clears snap ring groove, then remove ring with screwdriver and take plate out when tool is detached.

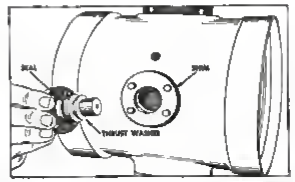


Fig. 14. After second flange has been taken apart, remove four nuts from synchronizer shaft flange studs and take out shaft, seal, and thrust washer, holding all parts from inside hub to prevent their falling. Laminated shim should be carefully removed from studs. On reassembly, laminations may be peeled from shim if gear clearance adjustment is found to be needed.

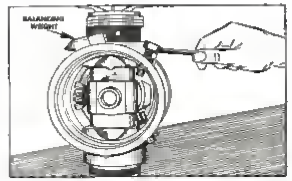


Fig. 15. Remove stop bolts and shims, marking each so that it will be returned to same position for correct assembly. Balancing weight should not be removed unless necessary, in which case original position should be marked before removing. Remove oil filler plug from side of hub. Keep all ports covered and free from dust or grit, and wash immediately before reassembly.

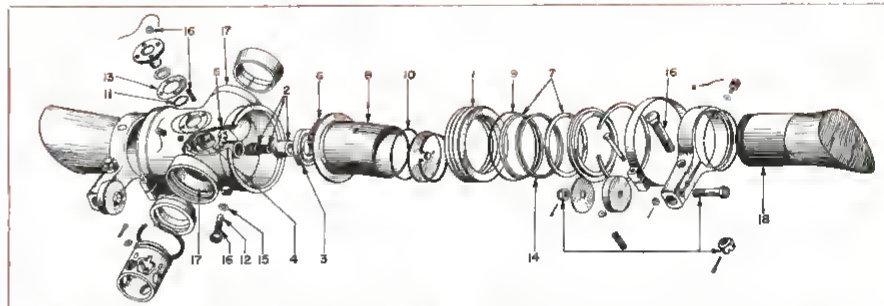


Fig. 16. Inspection should take place after thorough cleaning in gasoline or cleaning fluid. Thrust bearing (1) should show no rust or broken surfaces. Preloader (2) and radial bearing (3) should be free and bright, showing no cracks. Synchronizer gear (4) bushing should not show visible wear, and teeth on (5) and (6) should be smooth and serviceable. Flange oil packings (7) should be free of feathering or breaks, while contacting flanges (8) must be smooth. Seal rings (9), (10), and (11) must have no breaks or feather edges, but (10) may be slightly flattened without harm if surface is undamaged. Ends of stop bolts (12) should be in good condition. Shims (13), (14), and (15), also threads (16), and cone seats in hub (17), should be undamaged. If ferrule head screws (18), in table shanks, are loose, they should be tightened to 110 in./lb. torque. All steel parts must be Magnafluxed. Details of reassembling Aeromatic propeller will be given in August.

HOW TO "SIZE" THE OVERHAUL SHOP

PART VI OF A SERIES

By E. F. LINDSLEY

Success of a business organization depends on proper balance of its various components—here is a formula to make sure the maintenance end is designed to fit the kind of work which the operator may reasonably expect.

ONCE THE OVERHAUL shop operator has organized the business foundation of his enterprise, he must turn to the task of analyzing and organizing its working. Here, there are several well defined patterns. Continuous-flow, mass production methods, intermittent process, custom shop procedures, supplements to airplane shops or sales organizations—all have a place. In the case of an airline, it is found that the most logical plan is better defined than it is for a man bent on setting up an overhaul shop as a business.

It must be assumed that a certain market exists in the organizer's mind. Before the business organization was planned, one prime question should have been answered. "Exactly what type of overhaul shop are we going to operate? Will it be a large, continuous flow, contract shop? Or will it be a more modest business, overhauling all manner of engines? Will it supplement an airplane shop? Or will it be an integrated function of an operating organization, as with an airline or charter service?" The answers are vital. Only when the program is thoroughly understood by all concerned is it time to start on the shop plans.

In order to fix clearly the distinctions between continuous flow and an intermittent overhaul operation, let us examine the characteristics of each and compare a few samples of actual shops.

Intermittent process or "custom" overhaul is well adapted to the requirements of most job or contract shops, sales and service agencies, and moderate-size airlines. Such overhaul places an engine on the same basis as a watch in a watch repair shop. Each engine is a project in itself. The continuous flow or mass production shop is suitable for agencies undertaking a large number of overhauls on similar engines; for instance, the very large airline, military overhaul depot, or extremely large contract overhaul station where engines receive little, if any, individual attention.

Differentiating physical factors are building size, extensiveness of equipment, type of personnel, shop layout, and the functional plan which must be selected to suit the job at hand. Less tangible, but equally important, are business objectives, also the spirit underlying the entire organization.

A typical intermittent-process overhaul shop will handle 100–150 overhauls per year on engines of about 1,200 hp. This will be accomplished by a total shop force of 20–30 men. In this last item, shop personnel, may be found a key to the supremely fine work and amazing efficiency that have characterized airline maintenance both before, and more particularly during the war. The private overhaul shop operator will do well to observe the airline's policies in shop personnel for economy of operation and quality work are highly dependent on employee versatility and skill.

The 20–30 men mentioned above will normally include a few who devote their entire time to cleaning airplanes and engine parts with another one or two classified as inspectors or shop foreman, while the rest will spread their labors over the airplane, engine, propeller, and machine shop jobs as required. Each man should be expert in several lines.

Intermittent process shops are further distinguished by their equipment, and tied in with this, their functional setup. Any shop is interested in saving labor and time but sound economics do not always call for extensive conveyor lines, automatic industrial washing machines, huge machine shops and the subordination of all else to the saving of a few minutes in the flow of parts through the shop.

In general, portable parts racks of the castered type, manually operated parts cleaners, and small but adequate machine shops that refer to the engine manufacturer for major reworks, have served well in the past and will continue to do so for some time to come.

Following are two typical examples of the small flexibly operated type of overhaul shop just discussed. Both examples happen to be medium sized air lines; later we will discuss another similar shop operating as a profitable business in the limited private owner field.

The first airline operates 17 engines of 1,200 hp. for 700 hr. between overhauls. This time accumulates in approximately two months; therefore about 102 overhauls are required during a year's operation.

From a total of 20 shop employees 7 are assigned exclusively to engine overhaul. Since the accessory crew and cleaning section spread their work over a great many varied projects they are not included in the 7-man group. Other employees might work in the machine shop, on an airplane part, or a piece of line equipment or in the propeller, instrument, or cleaning sections.

From the organizational angle, the shop superintendent heads both the engine overhaul and the flight hangar. Next is the engine overhaul foreman. The cleaning crew is provided with a leadman; the rest of the shop dispenses with this supervisory level since each employee is an expert or a specialist in his own right. The shop foreman also functions as a chief inspector.

Those readers who are familiar with military overhaul agencies, may notice the complete absence of packing, preserving, and storage personnel in the foregoing plan. This situation stems from the commercial engine's characteristically rapid shuttle from airliner to overhaul shop, and back into the airplane again. At no time does an engine have a chance to rest long enough to require extensive corrosion protective measures, or even crating for shipment. On the extremely rare occasions when it is necessary to change an engine elsewhere than at the overhaul base, the engines are simply loaded aboard a truck and rolled to their destination without the delays necessarily encountered in military shipping.

The second example is another airline maintenance shop which is outstanding for the quality of its work and the ingenuity of its personnel. This organization works 16 Wright Cyclone G202 engines 800 hr. between overhauls. Any given engine accumulates its time in about 2 months to 10 weeks. Here the personnel organization is somewhat different; each section has a leadman or his equivalent, as shown in Fig. 1.

All members of this engine overhaul group are noteworthy for their devotion to the principle of building the engine perfectly, regardless of the effort or pains required. These men move from job to job constantly, and as a result they gain not only a wide experience but also an enlightened perspective of each engine part's importance in its relation to the entire assembly. Also, this practice eliminates bottlenecks arising from one specialized worker's absence due to illness or vacations.

These mechanics own and take pride in their private tool kits. During slow periods they are encouraged to spend their time developing and building new equipment, tools, gadgets, and experimenting with ideas for improved operation.

This organization is the modern outgrowth of the old-time closely-knit craftsmen's guild. It is admirably suited to the airline its serves, and it stands, moreover, as a shining example for those who would plan a general overhaul service for private airplanes. The keystone of such a shop is personnel selection also credited are friendly, personal, supervisory contacts dealing with each man as a respected craftsman.

At the opposite pole, as far as organization is concerned, is the continuous-flow overhaul shop (Fig. 2). Before examining a sample of this kind of shop, let us consider the various factors that automatically eliminate the versatile mechanics that contribute so much to the small shop. First, it would probably be physically impossible to locate the great number of skilled mechanics required. A large overhaul depot for example, employs about 1,200 people. Second, the constant shifting of personnel from section to section and job to job would soon spell hopeless confusion and practically eliminate any chance of careful supervision.

Many other factors enter this picture. For instance if the shop works several shifts, one worker must be able to pick up where the other left off without finding that the first man was going about the job in a distinctly individual manner.

There must be no doubt as to whether the men use the proper tools. Rather than take chances on makeshift devices and dangerous practices, the employee-owned tool system is ruled out in favor of carefully chosen tools, in good condition, available from the tool crib. If conveyor systems and mass production lines are established, it is essential that all stations be manned by workers who know the specific

(*Turn to page 249*)

AIRLINE ENGINE MAINTENANCE SHOP PERSONNEL

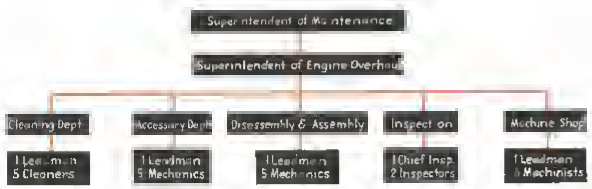


Fig. 1. Organization diagram showing distribution of engine maintenance personnel in the airline overhaul shop.

CONTINUOUS-FLOW OVERHAUL DEPOT ORGANIZATION

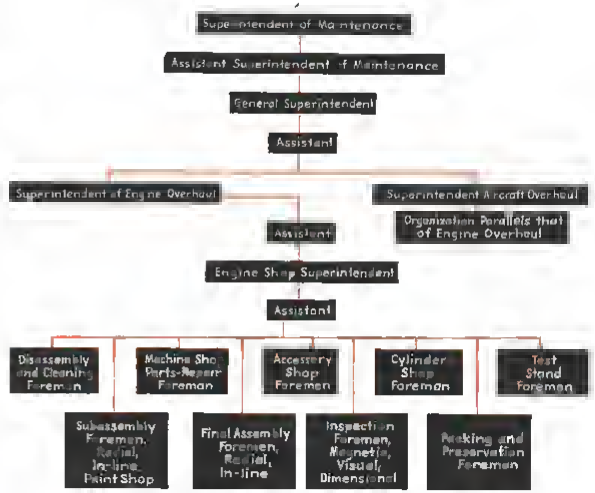
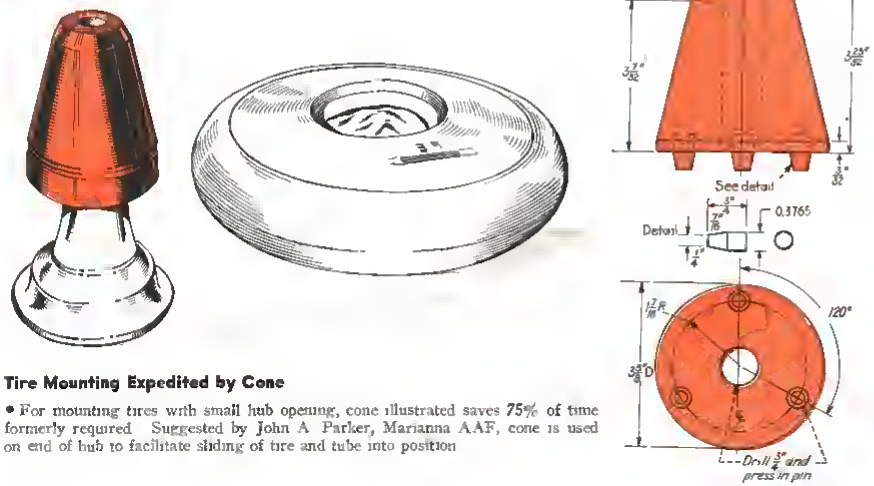


Fig. 2. Contrast this continuous-flow overhaul depot organization chart with that of the airline shop in Fig. 1, noting complete difference in personnel setup.

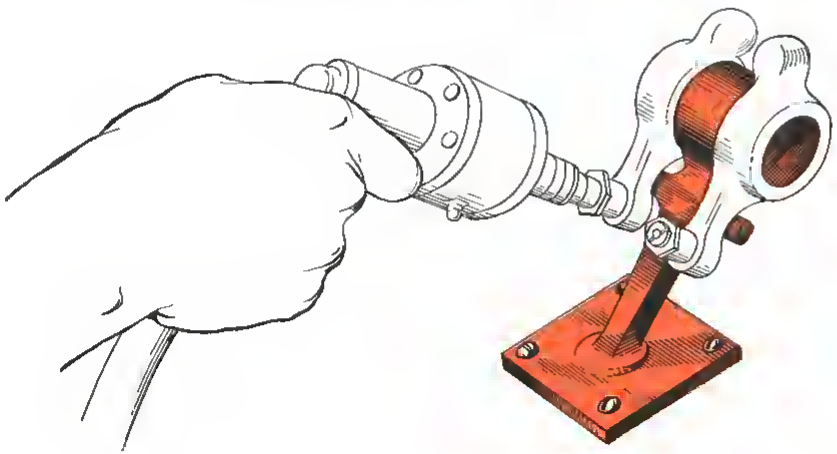


Tire Mounting Expedited by Cone

• For mounting tires with small hub opening, cone illustrated saves 75% of time formerly required. Suggested by John A. Parker, Marianna AAF, cone is used on end of hub to facilitate sliding of tire and tube into position

Rocker Arm Stand Protects Hands

• For installing valve adjusting screw assembly on rocker arms, E. O. Steitle, of San Antonio ATSC, built this special support, onto which rocker slides, being held in position by cross arm. Rocker may be reversed if it is desired to clean threads by running tap from back



Mexico City's airport as it is today. Its expansive layout is keyed to accommodate the increasing traffic now promised as transport operators draft broad plans for postwar networks meeting long-unfulfilled needs of Republic. (Wide World photo)

HOW MEXICO IS GIRDING FOR TOMORROW'S AIR TRANSPORT

By A. A. HARTSINCK

With much of its ground travel curbed, or at best circuitous, due to barriers of terrain, Mexico looks to the air for a solution of its transportation difficulties—and the solution bids fair to expand the country's economy to a status more nearly commensurate with its vast potentials. Here is a detailed analysis of the Republic's air transport picture, written by an aviation consultant after a first-hand survey.

DURING THE PAST YEAR, much attention has been focussed on the development of civil aviation in our neighboring Mexico. This country has long been an operating sphere for Pan American Airways and its subsidiary, Compania Mexicana de Aviacion (CMA), these services being carried on successfully for many years, with only competition of sorts from the smaller operators.

However, during 1943 and 1944, other airlines developed pointed interest in airline operations in the Mexican Republic, notably, American operators started new companies or bought control of existing airlines. One of these enterprises is Lineas Aereas Mexicanas, SA, better known as LAMSA, owned by United Airlines. Another is Aerovias Braniff, SA, a new company set up by Tom Braniff.

Other companies are controlled by American capital; for instance, Aeronaves de Mexico, SA, is a partial subsidiary of the Pan American Airways System, while Aero-Transportes, SA, is controlled for 66⅔% by two Richmond, Va., businessmen, Messrs. Markel and Brinson. Furthermore, during the past few months, another airline has appeared on the scene, Aerovias Azteca, SA, which is primarily financed by a group of Los Angeles businessmen without prior aviation experience.

This new carrier, little publicized as yet, obtained what are believed to be the first commercial air cargo certificates in Mexico, besides extensive concessions for passenger routes, which in many respects virtually duplicate CMA's routes and which total some 7,900 mi. covering most of the Republic. The line is reported to have started initial operations with two Budd RB-1 Conestoga's on Apr. 1.

To properly assay the air transport position in which Mexico now finds itself, mere statistics and reviews of the development of the various airlines are unsatisfactory. No comparison of the extent of the Mexican airline network with that of the United States should be made without further consideration of the country itself and of its broad status regards transportation facilities.

While it is quite true that at the end of 1944 there were some 35,500 mi. of airlines in operation in Mexico, over 7,000 mi. were classed as "international." These latter operations included American Airlines' run to

Mexico City from the United States, Transportes Aereos Centro Americanos', Mexico City-San Salvador operation, Braniff Airways' shortcuts across Mexican territory, and Pan American's services, via Mexico City to the Canal Zone and South America.

In other words, only 28,500 mi of the routes can be classed as truly domestic operations and even these are not all available to the traveling public. Certain factories and large plantations operate about 3,800 mi of private routes, and another 1,000 mi are pure cargo operations, leaving a net of some 23,700 mi for transportation of the public clientele.

In addition, there are also outstanding certificates for another 17,200 mi of routes, of which Aerovias Braniff holds over 7,800 mi and Aerovias Azteca over 7,900 mi of which some 4,800 are cargo routes and 3,100 passenger lines. The balance of 1,500 mi consists of about 650 of cargo routes and 850 mi of passenger routes.

Thus, Mexico with its population of some 20,000,000 and 765,000 sq mi of land boasts no less than 52,700 mi of certificated air routes, of which 23,700 are operating passenger-carrying aircraft for the public's use, with another 3,800 mi for private use. This compares with the 48,000 mi of routes operated by the domestic airlines in the United States which are serving 130,000,000 people and cover an area of more than 3,000,000 sq mi.

To the observer who digs no deeper, this appears to show that Mexico has ample route mileage. But this comparison fails to give sufficient consideration to the basic problem facing the Mexicans. To really get to the bottom of the reason for this enormous mileage of air routes operating or on the verge of operating in Mexico the nature of the people and of the facilities which are available for their transportation should be studied more carefully. And some attempt should be made to fathom the average Mexican's future plans and viewpoints.

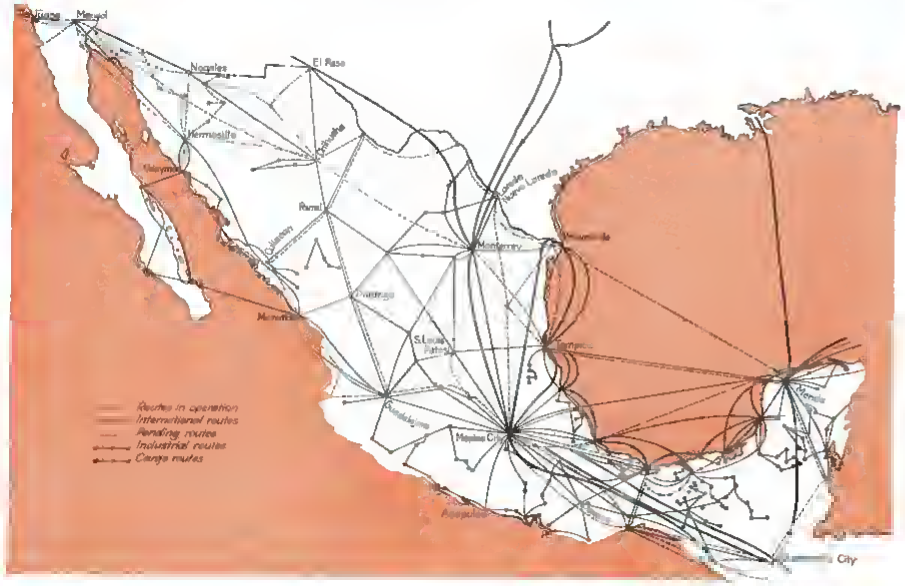
In the first place, Mexican officials such as far-seeing Gen. Alfredo Lezama, head of the Civil Aviation Department, readily admit that there currently is a minor state of chaos in civil aviation in our sister republic. But it is also quite obvious that steps have been taken to improve the airline picture. There was a time when issuance of certificates for operation of air routes was largely dependent on the political pull of the petitioner and not on his ability to actually operate the routes if he should get the certificates. Sometimes exemptions from regulatory terms of the concession were obtained, thus affecting proper operation.

The total certificates which have been issued during the past ten years are estimated at more than 100,000 mi but the mortality rate is astoundingly high, and of the 17,000 odd mi which were not in operation at the end of 1944 it is quite well possible that half will never be started.

The certificates which are being issued, at greater and greater intervals, contain terms foreign to operators in the United States. These include construction of airports, station buildings at the fields and in the cities, installation of such equipment as complete two-way radio facilities, radio beams, and direction finders, and passenger and crew insurance, etc. If such terms are enforced—and it appears that they will be—the new operators will *have* to run first-class airlines. There are also restrictions against flying passengers and cargo in one airplane, separate cargo and passenger planes being called for, though passenger planes may carry mail and some express. Further, requirements for the airworthiness of aircraft are being tightened.

There is pressure on many of the small "bush" operators to either sell out to larger companies with the financial backing to properly equip them with modern twin-engined equipment, or to undertake the modernization themselves.

Advent of Aeronautical Radio de Mexico, S.A., a subsidiary of the Amer



ican company will relieve many companies of the expense of installing radio equipment on the ground, since they can contract with ARMSA for complete service. But they will still be forced to obtain new equipment and modern shops.

It is not the province of this article to go into a detailed study of the financial position of the airlines in Mexico, but suffice it to say that the larger operators, with modern equipment like Boeings, Douglas C-39's and DC-3's, and Lockheeds, are definitely making money, and that the smaller operators, while making a little money, or just breaking even, have neither the experience, personnel, or capital to undertake modernization.

In many cases therefore, the smaller lines are selling out at sometimes quite fantastic profits to the large companies, very few of them are felt to be in a position to comply with the ever more stringent requirements of the Mexican Government.

With Government pressure, therefore, there is a definite tendency of the Mexican airlines complement to resolve itself into a smaller number of financially solvent operators with modern equipment and facilities. This drive is being spearheaded by Pan American, through CMA and Aeronaves, and by Braniff, LAMSA, Aero-Transportes, and Azteca.

The situation is similar in many respects, to that existing in the U. S. in 1930, and the Mexicans are frank to warm those who they feel are *simpatico* that they know they are years behind, but just watch them catch up in the next few years!

In the second place, surface transportation in Mexico is abominably bad. The country has some 14,000 mi. of railroads (6% of the U. S. Class I rail mileage), and much of this mileage is narrow gage, virtually all single track. Moreover, there are only 8,000 mi. of highways which are passable at all times (against more than 3,000,000 mi. in this country) and that word "passable" in many cases should be taken with a grain of salt. Often the roads only run to places of interest to tourists rather than to businessmen, sometimes ending miles from nowhere (while awaiting completion "*manana*"). Many of the roads cross mountain terrain at 10,000 ft. or more, with hairpin curves and sheer unguarded drops of thousands of feet, hardly suitable for heavy trucking even where the road surfaces might be considered good.

Status of railroad service in Mexico is exemplified by the rail connections between Mexico City and Guadalajara, the two most important cities in the Republic. Mexico City, of course, is the national capital, while Guadalajara is the second largest city, capital of the important state of Jalisco and trade center for the entire Western section of the Republic. Notwithstanding this, there are only two trains per day in each direction—the express-sleeper leaving at night and taking about 13 hr. for the 388 mi. (if it arrives on time), and the local departing very early in the morning and bringing the traveler to his destination in a little over 18 hr., making stops at an average of less than 5 mi. intervals all along the way.

In considering these connections, it should not be forgotten that this is the fastest roadbed in Mexico, and that the train service is considered the best offered by the National Railways.

In addition, there are a number of first, second, and third class bus services, plus one direct air connection via CMA. Since this airline section is part of CMA's international route from Mexico City to Los Angeles, it is booked up months in advance; immediate transportation, that is within two or three days, is available only to priority passengers or to travelers who are able to pay exorbitant "special reservation fees" for a seat.

While service fees or tips are common on all forms of transportation to obtain good space, this system has not extended too much to the airlines, except where the loads are exceptionally heavy. These fees run from 25 *pesos* ($5) for a Merida-Minatitlan reservation to 500 ($100) for a prompt Mexico City-Los Angeles trip. Even so, the average Mexican traveler expects this, and only gets angry when paying a high fee for a reservation in some conveyance which is later found to be virtually empty.

In the third place, the majority of all U. S. airline operations is with large planes, the average seating capacity for our entire domestic industry being 16½ seats per mile, while in Mexico it is estimated at only a little over 6 seats. Moreover, the airlines in this country operate at a frequency of ten one-way trips per day over the entire domestic network, while in Mexico the average is estimated at less than two trips per day. Many of the Mexican airlines operate from one to three times per week, except on such highly traveled sections as Mexico City to Merida, where there are actually two schedules per day (booked months in advance) and Mexico City to Los Angeles, which is flown daily.

The seemingly enormous mileage differential between the United States and Mexico is therefore reduced, by the service denominator, to a size somewhat more in proportion with the population and area of the country.

Finally, the average Mexican, besides being acutely and rightly proud

(*Turn to page 270*)

AIRLINES IN MEXICO
(As of Oct. 31, 1944)

Code Number	Company	Kilometers Certificated
International Routes		
1	Pan American Airways	9,113
2	Americana Airlines	4,028
3	Braniff Airways	235
4	Transportes Aereos Centro Americanos TACA	1,246
Domestic Routes (Passengers, Mail and Express).		
11	Cia. Mexicana de Aviacion SA (CMA)	11,435
12	Servicio Aereo Panal (Panal)	3,035
13	Lineas Aereas Mexicanas SA (LAMSA)	6,423
14	Transportes Aereos Mexicanos SA (TAMSA)	3,590
15	Comunicaciones Aereas de Veracruz SA	3,235
16	Transportes Aereos de Jalisco	407
17	Aeronaves de Mexico SA (Aeronaves)	9,262
18	Transportes Aereos de Tampico, S. de R. L.	168
19	Empresa Aerochiclera, SA	292
20	Aero-Transportes SA	2,290
21	P. A. Leopoldo Reyes T.	401
22	Guillermo L. Taboada	113
23	Aerovias Braniff, S. A. (Braniff) (1)	12,422
24	Sociedad Mercantil y de Comisiones S. de R. L.	274
25	Helicopteros de Mexico SA (1)	Radial
26	Aero-Transportes de Sonora, S. A. de C. V.	1,307
Domestic Routes (Cargo only)		
101	Transportes Aereos Mexicanos, SA (TAMSA)	1,819
102	Cia. Mexicana de Navegacion, S. de R. L. de C. V.	1,174
Domestic Routes (Industrial service) (2)		
201	Antonio Gutierrez Sandoval	301
202	Ricardo Navarez	454
203	Cooperativa 'Los Chenes'	636
204	Pedro Silveira, Juan Herrera y M. Medina	113
205	Antonio del Rio	509
206	Cia. Mexicana Constructora Azteca SA	2,782
207	Nicolas Gonzalez	420
208	Guillermo L. Taboada	82
209	Oscar Francke de la Pena	820
210	Pedro y Lisandro Lara	140
	Total Km.'s	72,092

(1) Not in operation as of Oct. 31, 1944
(2) These are air services operated by large ranches or factories in inaccessible areas.
Note: Aerovias Azteca S.A., which started experimental operations on Apr. 1, 1945, has 4,828 mi. of cargo routes and 2,103 mi. of passenger, mail and express routes.

HIGH SPEED FUEL PUMP CUTS SERVICE TIME

By fueling airliners in less time than passengers require to board it, new power unit makes enroute refueling feasible without affecting schedules.

THERE IS LITTLE REASON for sky-traveling at 200 mph. if time is wasted on the ground at intermediate stops in refuling and servicing the plane, nor is there profit in hauling large amounts of fuel in order to eliminate lost time at intermediate stops.

The obvious remedy is to refuel the airliner in no greater time than it takes to load passengers, doing the job at stops along the route.

In order to accomplish this, it is necessary to use equipment capable of handling much greater quantities of fuel per minute than has been customary, and for this purpose the Van Vleck Mfg. Co. has designed the pumping unit described herewith. Its ready acceptance by several major airlines is proof that need for this type of machine had already been recognized.

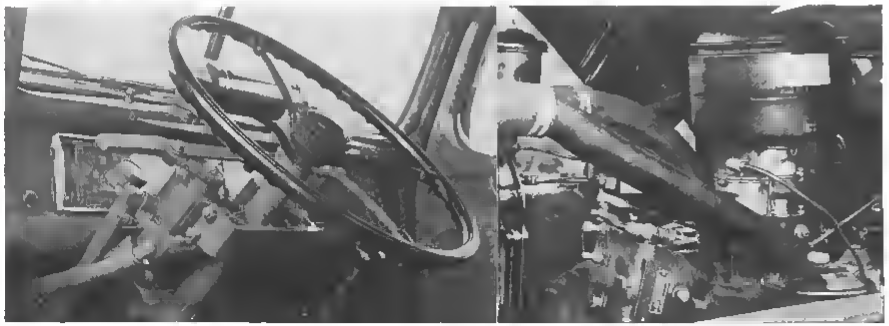
Made either in truck form (Fig. 1) or as a trailer, the unit consists essentially of four assemblies. The throw-in and brake lever mechanism (Fig. 2), pump speed governor (Fig. 3), speed stepup transmission (Fig. 4), and the pumping units (Fig. 5), of which there are two, each with a capacity of 150 gpm.

In the truck, the pump drive is directly from the power takeoff, while the trailer unit uses an engine-driven generator directly behind the cab, supplying power for enclosed electric motors at the pumps.

Throw-in lever (Fig. 1) operates a vacuum cylinder which moves the splined gear into engagement with the large bevel gear on the same shaft (Fig. 4). This gear drives the smaller gears on the pump shafts at 3¾ times the speed of the power shaft. At the same time that the gear is engaged by the sliding clutch, the lever automatically applies the brakes on the truck, thus making it impossible to start the pumps until the truck has been immobilized, and also preventing the vehicle from being driven away with fuel still flowing through the pumps. A single movement of the lever controls both the pump gears and brakes.

Fig. 1. With 300 gpm. pumping capacity, this truck cuts fueling time to a minimum.

Fig. 2. Lever under steering wheel applies brakes simultaneously with connecting pumps to power takeoff, rendering accidental starting impossible. Right: Fig. 3. Pump speed governor (lower left) only operates when pump is running. It holds engine at whatever speed is required to run pumps at 1,800 rpm., regardless of ratio of power takeoff thus insuring constant fuel delivery to tanks of plane.



Pump speed governor (Fig. 3) operates directly on engine throttle, but it is driven from the gear which operates the pump, keeping pump speed at 1,800 rpm., regardless of the gear ratio used at power takeoff.

Pumps are centrifugal, delivering fuel through 1½ in. hose. Since the pumps are below the tanks, no suction troubles are experienced, nor is there any variation in output from changes in pump feed. Each pump is independently driven and has a separate delivery, so that two hose lines may be used.

Hose rewind is power operated, saving time over the hand-winding method.

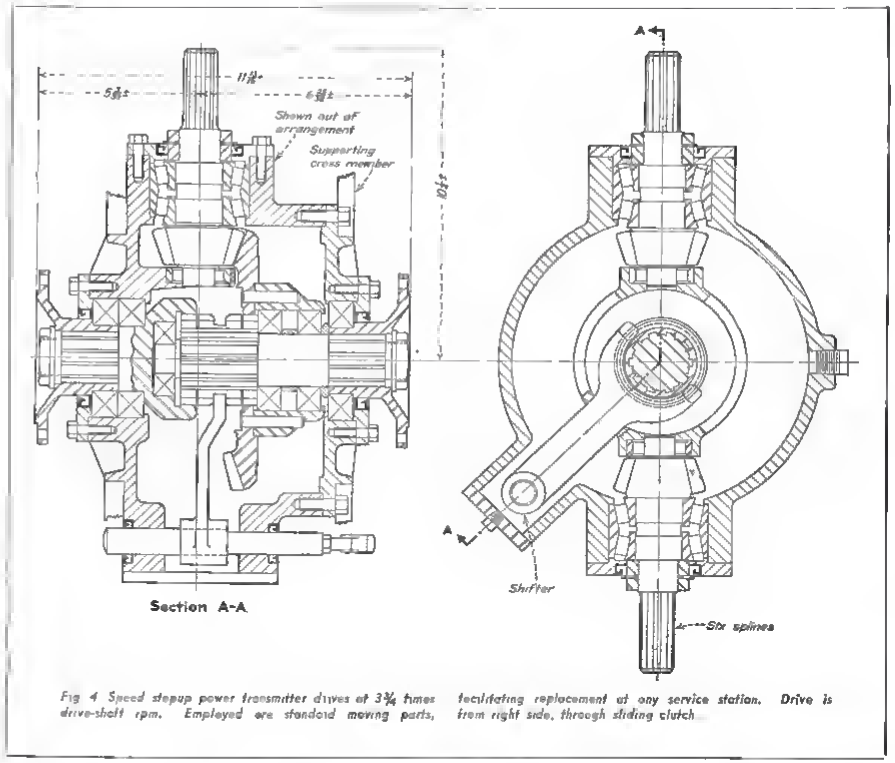
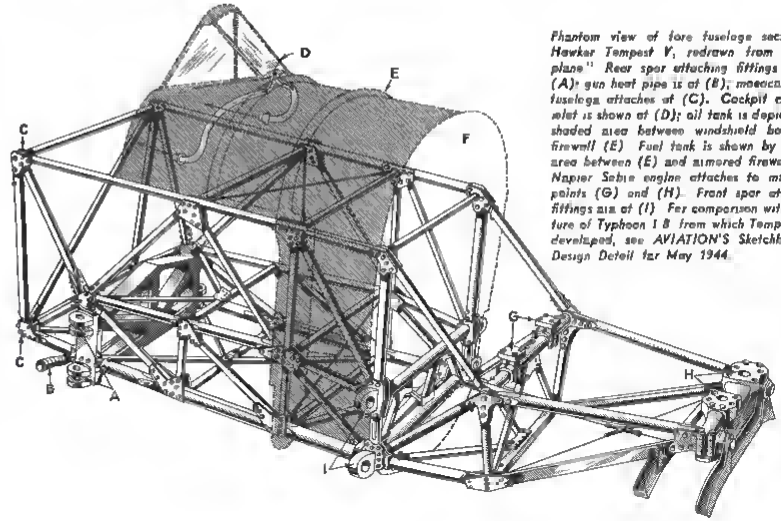
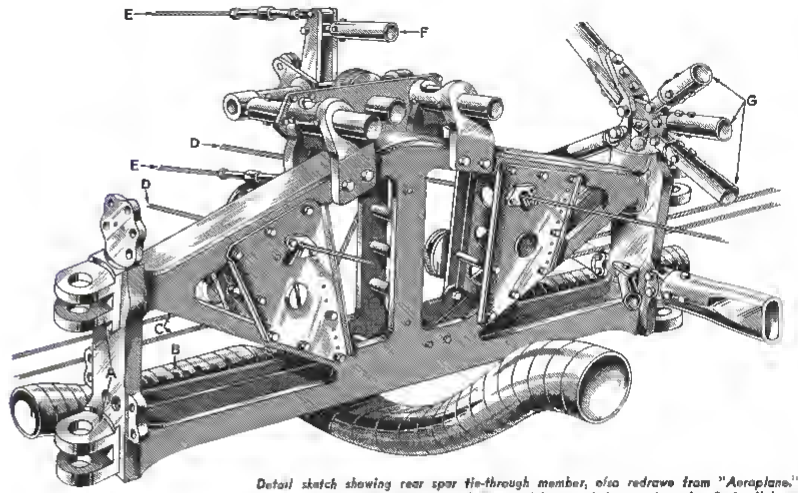


Fig. 4. Speed stepup power transmitter drives at 3¾ times drive-shaft rpm. Employed are standard moving parts, facilitating replacement at any service station. Drive is from right side, through sliding clutch.

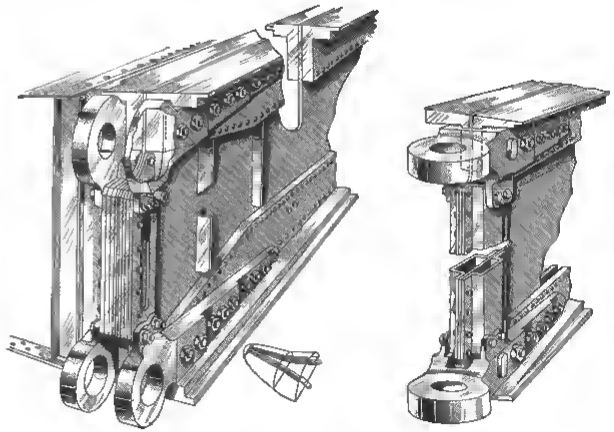
Fig. 5. One of two 150 gpm. pumps. Pump unit is at right, clutch lever above. Three parallel levers connect to various tanks. In center is meter, with hose reel at left. Driven by small elrmotor and chain, reel rewinds hose as fast as it can be handled.



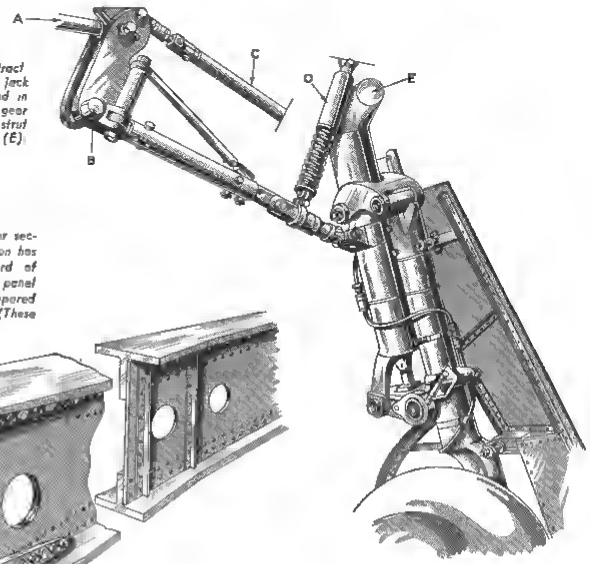
Phantom view of fore fuselage section of Hawker Tempest V, redrawn from "Aeroplane" Rear spar attaching fittings are at (A); gun heat pipe is at (B); mascaque oil fuselage attaches at (C). Cockpit cold air inlet is shown at (D); oil tank is depicted by shaded area between windshield base and firewall (E) Fuel tank is shown by shaded area between (E) and armored firewall (F) Napier Sabre engine attaches to mount at points (G) and (H) Front spar attaching fittings are at (I) For comparison with structure of Typhoon I B from which Tempest was developed, see AVIATION'S Sketchbook of Design Detail for May 1944



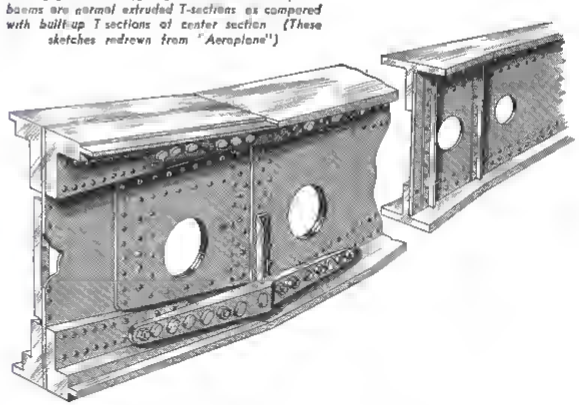
Detail sketch showing rear spar tie-through member, also redrawn from "Aeroplane." On Series I Tempest this member was built up of heavy tubular members, but Series II has single casting which has simplified rear spar fitting, shown at (A). Gun heat tube is at (B), aileron cables (C) rudder cables (D) elevator cables (E) torque tube to control stick (F) and fore fuselage members (G).



Cutaway views of root fittings of Hawker Tempest V front spar (left) and rear spar (right), with inset sketch showing relative positions in wing. Both spars have T-section booms built up of L-section extrusions riveted to heavy gage sheet web.



Detail sketch depicting Tempest V retractable landing gear, with retracting jack attached at (A), pulling unit up and in around hinge point (B). Locking gear strut is at (C); emergency assister strut is at (D). Oleo strut hinge point is at (E).

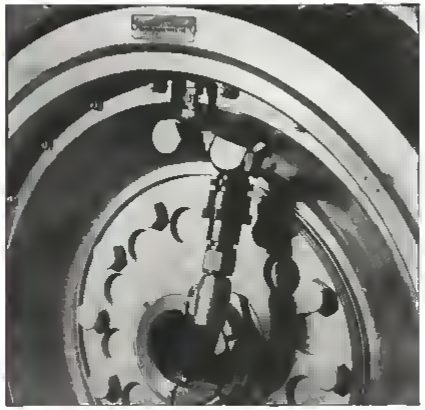


Front spar of Tempest V (below) where center section and outer panel are joined. Center section has no dihedral, outer panel—which is outboard of landing gear—has 5½ deg. Note that outer panel booms are normal extruded T-sections as compared with built-up T sections of center section. (These sketches redrawn from "Aeroplane")

WHEEL and BRAKE CHANGING TIME CUT 10 to 1

Reports on Self-sealing Couplings reveal large savings . . . Bleeding time eliminated.

Reductions in wheel and brake changing time of as much as 10 to 1 are reported on aircraft installations by the use of Aeroquip Self-sealing Couplings.



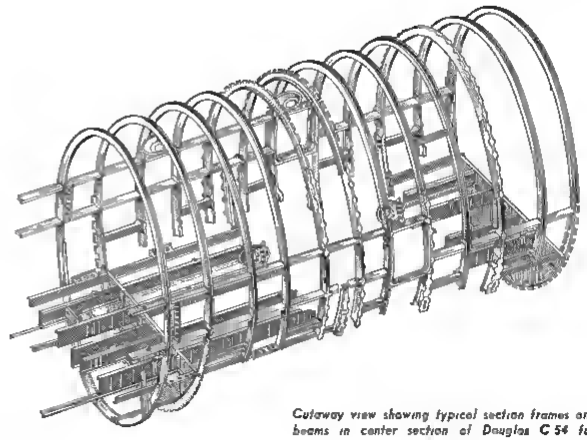
Aeroquip Self-sealing Coupling and Hose Line with Detachable Fittings installed on Hayes Wheel and Expander Tube Brakes

These couplings, whose instant sealing feature permits quick disconnection of hydraulic lines without loss of fluid and reconnection without admission of air, have changed the maintenance problems of hydraulic systems. Not only on wheel and brake changes, but also on all other fluid connections where disconnecting and reconnecting operations had created time-consuming problems of draining, refilling and bleeding, Aeroquip Self-sealing Couplings have introduced new elements of efficiency and economy.

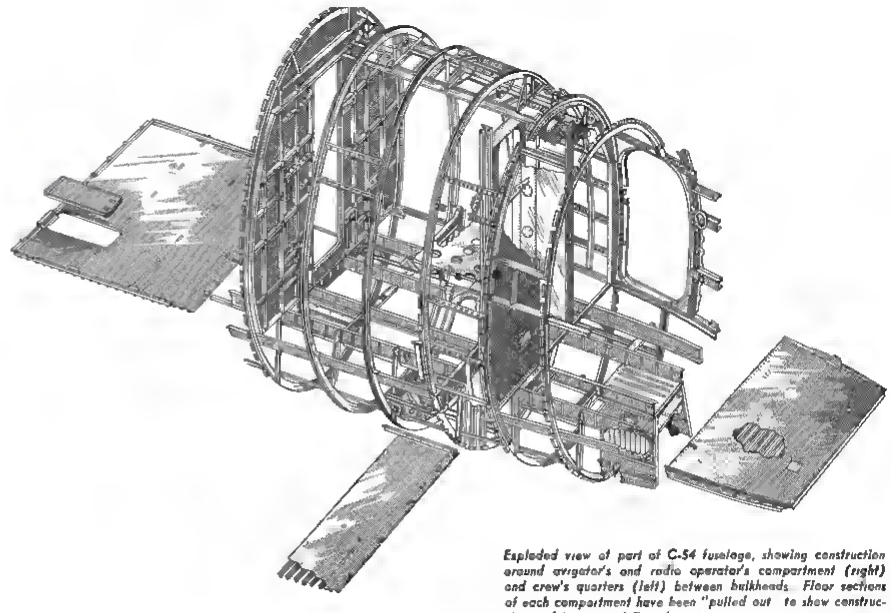
Reports of comparable installations cite such time reductions on wheel and brake changes as from 75 minutes to 7½ minutes, after equipping with self-sealing couplings.

These couplings and Aeroquip Hose Lines with Detachable Fittings present an effective combination for efficient hydraulic system performance. The hose line fittings, all parts of which are replaceable individually, are readily removed and reused on new lines which can be cut to any desired lengths and installed on the job.

It is predicted that these Aeroquip Self-sealing Couplings, Hose Lines and Detachable Fittings, now in rugged use on military and naval aircraft around the world, will have extensive applications to machinery and other products in post-war design.



Cutaway view showing typical section frames and floor beams in center section of Douglas C-54 fuselage



Exploded view of part of C-54 fuselage, showing construction around navigator's and radio operator's compartment (right) and crew's quarters (left) between bulkheads. Floor sections of each compartment have been "pulled out" to show construction and location of floor beams

Aerodynamic, Weight, and Servicing Refinements Featured in North American P-51

CONTINUED ADVANCES in engineering of the Mustang reflect improvements of specific interest to the aircraft designer. Among these are betterments in such installations as landing gear fairing door, landing light, gun and ammunition bay doors, shell ejection chutes, and the armored firewall.

Fairing Door

This hydraulically operated inboard unit, covering the wheel well, is hinged close to the airplane centerline, and is designed to open to permit extension of the landing gear and then close after the gear is extended. Eliminating a source of drag, the door has an area in excess of 4 sq. ft. and thus adds considerably to the lifting area of the wing—an important factor at takeoff with heavy bomb load under each wing.

Also, gravel and dirt from the propeller blast are prevented from entering the wheel well compartment and coming in contact with landing gear and door lock mechanisms, hydraulic lines, coolant pipes, and wiring circuits immediately accessible through the door opening.

And for ground operation of the plane, the closed fairing door eliminates interference with the flow to the large airscoop installation, behind and below the wheel well.

Landing Light

NAA engineers found that the leading edge was not the most desirable location for the landing light, since the Mustang wing is comparatively thinner because of its laminar flow design. Curvature of the lens in the wing edge also caused refraction.

By relocating the light in the wheel well, lighting efficiency has been improved by about 40 percent.

In its new location, the installation is readily accessible for quick replacement, the light beam is not obstructed, and intersection with the propeller arc is below the pilot's line of vision.

Control switch for the light is mounted on the pilot's switch panel. A spring-loaded safety switch, actuated by the support arm for the light, is connected in series with the control switch, and breaks the circuit when the landing gear strut fairing pushes the light upward into the wheel well.

Providing additional lifting area of over 4 sq. ft., P-51 landing gear inboard fairing door seen at top in normal closed position when gear is extended, open (as shown at right) to permit wheel to be retracted, then closes again. Installation protects gear mechanisms and plumbing from gravel and dirt, and presents no interference to flow to airscoop. Also visible is landing light relocated from wing. When gear is retracted, fairing on strut contacts roller under lamp housing and pushes unit into recess.

Armament Access

Gun and ammunition bay doors on the P-51 embody good design for quick and easy access to armament compartments.

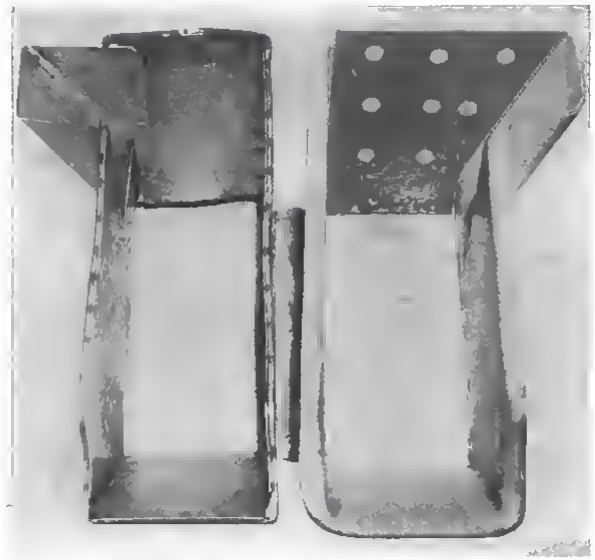
Access to the bays in either wing is obtained by loosening two fasteners which safety two cover latch handles, swinging the handles up, and opening the forward cover. Rear cover of the

First step for quick access to gun and ammunition bays of Mustang is loosening of two fasteners in the cover latch handles. This permits raising of cover over forward part of gun bay.

With hinged cover raised, rear cover of gun bay may then be removed by pushing forward. Access to ammunition bay on right is had by raising short lever to free one side of ammunition bay cover.

With ammunition bay cover unlocked, it is pulled backward and lifted out with aid of handhold at right. Note that rear cover of gun bay has been removed at the left.

In replacement procedure, rear cover of gun bay or ammunition bay cover may be installed first.



Here (left) is seen stainless steel shell ejection chute after some thousands of rounds had been fired. Note result of peening action of shell cases. Shown at right, at conclusion of same number of rounds, is new phenolic fiber chute with similar material for striking plate. It exhibits superior characteristics.

gun bay may then be lifted out to fully expose the three 50-cal. guns.

Access to the ammunition bay is provided by raising a handle in the gun bay to free one side of the ammunition bay cover, which then may be lifted out. This gives access to the three ammunition belts.

The two removable doors are replaced first, and the hinged gun bay door is closed last. This interlocking door arrangement greatly speeds work of armament men when servicing the guns and reloading between combat missions.

Shell-Ejection Chutes

Phenolic fiber shell-ejection chutes recently designed for the Mustang have been found superior to stainless steel for this purpose, after exhaustive firing tests.

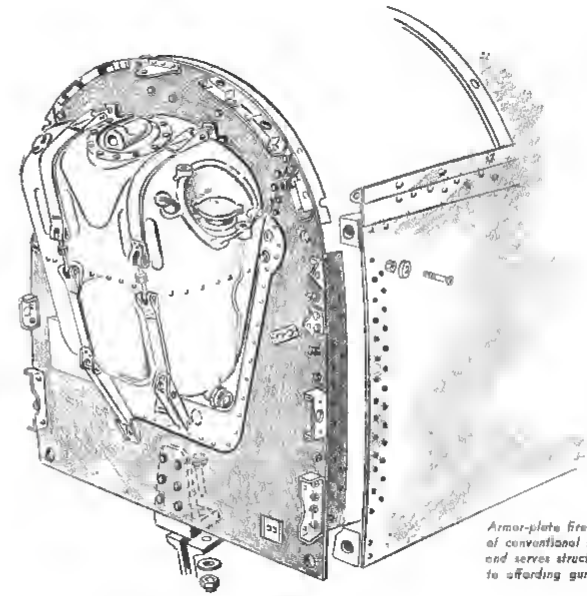
Impact of the 50-cal. brass shell cases against the ejection chute edges caused warping of the stainless steel, which would not return to its original formed shape. Also, peening action of the empty cases against rivets on the inside of the striking plate damaged them so severely that at the end of some 4,230 rounds the plate fell off.

The fiber chute acted as a cushion for the shell cases, and after firing more than 10,000 rounds, examination showed the new installation to be superior.

Also, phenolic fiber chutes are quicker to manufacture — requiring only about 25 min. compared to more than 1 hr. for the stainless steel chutes.

Firewall

Designed to save weight and material, the firewall on the P-51 is fabricated of armor plate and does double duty by serving as a structural member attaching to upper and lower longerons, and providing protection for the pilot from frontal enemy gunfire. The installation thus eliminates the need for the usual stainless steel firewall with additional backing of armor plate.



Armor-plate firewall on P-51 takes place of conventional stainless steel installation and serves structural purpose in addition to affording gunfire protection.

AVIATION'S ENGINEERING **DATA BOOK**

SHEET NUMBER . . . D-29
CLASSIFICATION . . MATERIALS
SUB CLASSIFICATION . PLYWOOD

Characteristics, Sizes and Weights Of Standard Plywoods

Physicol Properties of 3-Ply Plywood

(8 to 10 percent moisture)

SPECIES	Average Specific Gravity over-dry weight air-dry volume	Column Bending Modulus lb per sq in. load applied parallel to grain	Modulus of Elasticity Column bending 1 000 lb. per sq in.	Tensile Strength lb. per sq. in. parallel to grain	Tensile Strength lb. per sq. in. perpendicular to grain	Compression Fiber Stress, lb per sq. in.	Splitting Resistance, percent of birch	Service Suitable for A	B	C	D
HARDWOODS											
Ash Commercial white	0 60	9 930	1 420	8 510	4 350	5 250	71				
Basswood	0 42	7 120	1 210	6 680	4 300	5 370	63				X
Birch yellow	0 67	16 000	2 260	13 210	7 700	5 480	160	X	X	X	
Cottonwood	0 46	6 460	1 440	7 260	4 240	5 520	85				
Elm American	0 52	8 560	1 220	5 860	5 990	5 180	75		X	X	
Gum, tupelo	0 50	7 760	1 300	6 260	5 760		60				X
Mahogany, African	0 52	8 070	1 260	5 570	3 770	4 280			X	X	
Mahogany, Khaya	0 46	8 500	1 940	6 360	3 760	4 490			X	X	
Maple, hard	0 68	15 600	2 110	10 160	6 550	5 820	114	X	X	X	
Maple, soft	0 57	11 540	1 750	8 160	5 360		106		X	X	
Oak commercial white	0 64	10 400	1 540	6 750	4 200	4 950	85				
Poplar yellow	0 53	8 860	1 920	7 360	4 720	5 750	51				X
Sweetgum	0 54	9 570	1 590	7 850	4 930		80				
Sycamore, American	0 58	11 040	1 630	8 030	5 220		77		X	X	
Walnut black	0 59	12 860	1 740	8 250	5 260		77	X	X	X	
SOFTWOODS											
Cedar Spanish	0 41	6 460	1 030	5 200	3 340	4 320	60				X
Cypress, bald	0 45	6 890	1 220	6 160	3 980	4 950	49				
Fir Douglas	0 48	9 340	1 530	6 188	3 910	5 600	95				X
Hemlock western	0 47	9 250	1 580	6 600	4 540		63				X
Pine eastern white	0 42	10,130	1 570	5 720	5,340		31				X
long leaf						3 860					X
ponderosa						5 280					X
short leaf						4 240					X
sugar											X
	0 42	8 050	1 310	5 430	3 690	3 490	47				X
Redwood	0 42	8 230	1 160	4 770	2 660		48				X
Spruce, Sitka	0 42	7 710	1 370	5 650	5 410	4 000	78				X

A — Hardness, abrasion resistance and fastening strength B — Finish or appearance C — For plywood that is to be steamed or soaked before being bent into a form or shape that is to be permanent after forming D — For flat panels that require high bending or high column strength with minimum weight.

Courtesy Product Engineering Magazine

Sizes, Weights, and Stiffness of Aircroft Plywood

Thickness of Plywood, in	Number of Plies	BIRCH Estimated Weight lb per sq ft	BIRCH Stiffness Factor (EI) lb in. Long	BIRCH Stiffness Factor (EI) lb in. Trans.	POPLAR OR SPRUCE Estimated Weight lb per sq ft.	POPLAR OR SPRUCE Stiffness Factor (EI) lb in Long.	POPLAR OR SPRUCE Stiffness Factor (EI) lb in Trans.
1/32	5	0 18	7 5	0 5	0 15	5 3	0 5
3/64	3	0 21	15 8	1 5	0 15	9 5	1 2
1/16	5	0 29	41	5 5	0 19	30 0	4 0
5/64	3	0 33	70	4 7	0 22	51 5	3 4
5/32	5	0 42	24	24 0	0 29	119	17 4
1/8	3	0 50	290	57 5	0 34	212	42
5/32	5	0 64	650	80	0 43	480	60
3/16	3	0 75	970	185	0 49	705	135
5/16	5	0 78	905	330	0 53	660	240
1/4	5	1 00	2 000	650	0 66	1 460	490
9/32	5	1 16	3 900	1 270	0 77	2 860	925
5/16	5	1 32	4 225	1 690	0 87	3 080	1 225
5/8	5	1 56	6 350	3 000	1 04	4 765	2 825
1/2	7	2 05	18 400	7 500	1 38	11 970	5 650
5/8	9	2 52	24 700	16 250	1 65	21 100	13 520
3/4	9	2 97	42 500	28 800	1 97	36 900	21 680
1	11	3 90	121 000	64 300	2 57	88 400	88 425

MATERIAL	STIFFNESS (EI) FACTOR[1]
Spruce (lightest commercial natural-density) plywood	415 0
Birch (heaviest commercial natural-density) plywood	178 0
Tegewood (high-density plywood) 1/45 in birch veneers	30 0
Aluminum	22 0
Steel	5 1

[1] Obtained by multiplying the modulus of elasticity by the moment of inertia of a section 1 in. wide and of a thickness h equal to that of a sheet of the material 1 sq. ft. in area and weighing 0.43 lb. For birch, $h = 0.098$ in.; for spruce $h = 0.153$ in.

Courtesy U. S. Plywood Corp

Specifications for Ampoloy Continuous Cast Rod

THESE CONTINUOUS CAST BRONZES, adapted for use in automatic screw machines are produced by continuous withdrawal through the bottom of a casting crucible thence passing through a cooled die which gives required finish and accuracy

Alloy	Tin Bronze 742	High Lead Bronze 382	Bearing Bronze 342
Sizes available	¼-2" incl.	1⅛"-2" incl	1⅛"-2" incl.
Diameter tolerances	+.004"— .006"	Tentatively ± .010"	
Length tolerances	90% of rods ± 1"	75% of rods ± 1"	
	Max. of 10% shorter— none under 4'	Max. of 25% shorter— none under 4'	
Straightness	¼" maximum arc depth in 5' length		
Tensile strength psi	40 000	30 000	
Yield strength psi ½% ext. under load	18,000	14,000	
Elong 2"—%	14 0	12 0	
Rockwell	F 80 min.		
Brinell 500 kg			45–65
Copper %	86–89	81–85	Balance
Tin	9–11	6 25–7 50	4 25–5 5
Zinc	1–3	2 00–4 00	50 max.
Lead	30 max	6 00–8 00	18–22
Iron	.15 max	20 max.	20 max
Phosphorous	.05 max	03 max.	05 max
Nickel		.50 max.	.25 max
Antimony		25 max	
Others	25 max	35 max	25 max

(Courtesy Ampco Metal, Inc.)

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

CAA Converted to Meet Broad Postwar Needs; Assistant Administrators Now Head Services

. . . ATSC-GE conference reveals super-jet . . . "Spat" plan guides output of new personal craft . . . New non-transport ratings sought under CAR . . . House committee finishes airport bill hearings . . . High school aero courses keyed for postwar.

Reorganization of CAA has been completed "to meet the urgent problems of postwar expansion in civil aviation activities, both foreign and domestic," according to T P Wright, administrator

New setup further decentralizes CAA and provides for determination of policies, procedures and standards in Washington, with the Administration in the field Idea is to put CAA services within easy reach of all in aviation

Principal change is in the designation of assistant administrators in charge of new and existing services, who will have responsibility for technical and administrative policies and programs Under these assistants, directors of various services will organize their own activities in accordance with the new plan

On the administrator's personal staff are four advisory committees and four special assistants reporting directly to him The committees are Non-Scheduled Flying, Commerce-CAA State Legislation Statistical Coordination, and Executive Coordination

Special assistants are Edward M Sturhahn, executive assistant to the administrator, John H. Geisse, personal flying, Dean R. Brimhall, research, and E J Robins, state relations

ATSC-GE Conference Reveals Super-Jet

General Electric's new super-jet, called the "most powerful aircraft engine in the world which now drives the Lockheed P-80 faster than any other plane will fly", was shown reporters for the first time at conclusion of a three-day conference on jet propulsion at Swampscott, Mass attended by some 200 power plant and airframe engineers Sponsored by ATSC and GE, conference was designed to "stimulate new advances in jet propulsion and gas turbines through pooling of facts and ideas', and appeared to bring a veritable contest among participants to see who could make the most optimistic predictions.

Typical were prognostications of R G Standerwick GE engineer who directed design and development of the super-jet, who forecast that transcontinental passenger planes would be jet propelled within five years and of Brig Gen L. G. Craigie, Deputy Chief of

Coming Up

(Meetings and dates subject to wartime conditions under ODT regulations)

July 30 Executive Committee Meeting International Air Transport Assn, Paris

Aug 16 - 17. IAS Los Angeles Meeting.

Sept 2 Interhemisphere Conference on Frequency Allocations and Revisions Rio de Janeiro (Postponed from June 2)

Oct 4 - 5. IAS Light Aircraft Meeting, Detroit.

Oct. 4 and Nov 1 SAE Southern California Section Aeronautic Meeting Hotel Biltmore, Los Angeles

Oct. 15 (tentative) First Annual Meeting, International Air Transport Assn Montreal

Oct. 26 IAS Washington Meeting

Oct. 31 - Nov 3. 1945 National Aviation Clinic, Oklahoma City (Pre-clinic conferences start Oct 27.)

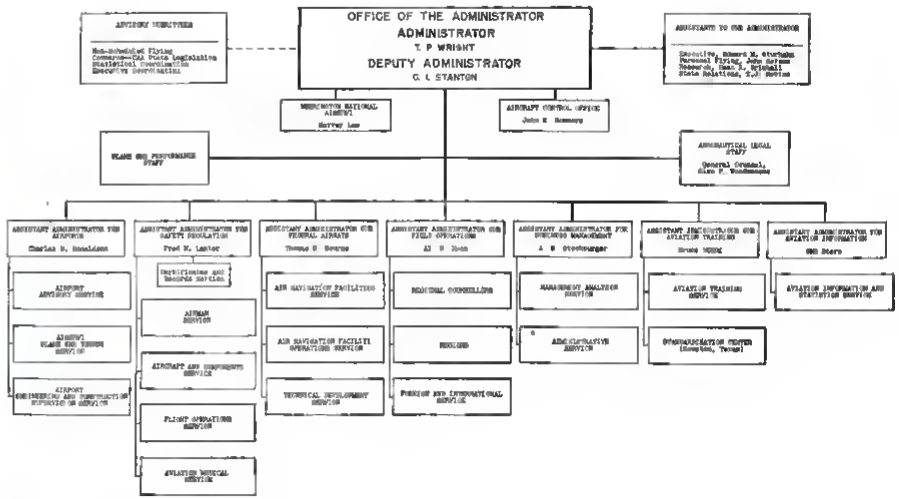
Nov. 15 IAS Engine & Accessories Meeting, Dayton

Dec. 17 IAS Wright Brothers Lecture Washington D C

DEPARTMENT OF COMMERCE

CIVIL AERONAUTICS ADMINISTRATION

ORGANIZATION CHART



ATSC Engineering div who said "We have within reach a new concept of military airplanes which will render obsolete and impotent the military airplane which played such an important role in the defeat of Germany"

All details as to performance, design and construction of the super-jet remain restricted

"Spot" Plan Guides Output Of New Personal Craft

Production of personal type airplanes has been authorized by WPB with priority assistance under the "spot authorization" plan This means that assistance will be given only when production does not interfere with the war effort

It is believed that the difficulty of getting certain materials and components will only permit manufacture of a few personal craft until late this year

However, Limitation Order L-48, limiting the transfer and manufacture of civilian airplanes, has been revoked hence producers are now on their own initiative.

New Non-Transport Ratings Sought Under CAR

CAB has distributed for comment a new proposed Part 03 of CAR establishing airworthiness standards for planes in non-transport categories

"Special Personal" category is intended for personal planes; "Normal" includes craft for passenger or cargo operations; and "Utility" covers planes used for normal flying and limited acrobatics in training An "Acrobatic" class will have no specific regulations as to type of maneuvers unless required test flights show such necessity

Both scheduled and non-scheduled flying, under present rules, are included in the presently effective Part .04 of CAR The transport category will continue in Part .04 which is also undergoing revision.

So that the industry may quickly know exactly what airworthiness standards will govern the manufacture of postwar airplanes, the date for return to CAB of comments had been set for July 2, 1945 or before. CAB will hold meetings shortly after to resolve any differences of opinion on the proposal

The Aero Chamber holds that setting up of Part 03 will complicate the CAR, contrary to CAA's policy.

House Committee Finishes Airport Bill Hearings

Redirection of high school aviation courses to meet postwar needs is reported by Dr Edgar Fuller of the CAA's Aviation Education Service Twelve states and the District of Columbia, covering 43% of the population of the U S, now have formulated comprehensive programs for this purpose.

In Massachusetts, 152 of the state's 253 public high schools have regular aviation courses this year, enrolling 4 023 students Connecticut and also Rhode Island show slightly higher percentages Tennessee currently has 371 high school students from 45 institutions taking four hours of flying as "laboratory work" in the curricula.

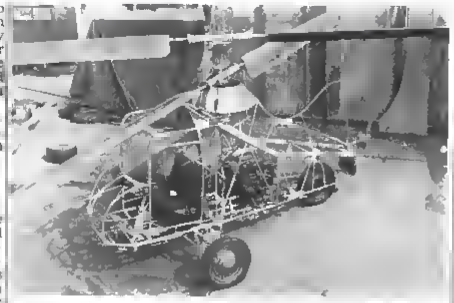
High School Aero Courses Keynd for Postwar

Hearings on HR-3170 Rep Clarence Lea's bill providing for federal aid in expanding the nation's airport system from 3 000 to 6 000 fields have been concluded by the House Interstate and Foreign Commerce Committee

Several other bills making the same basic provision were sidetracked in favor of Mr Lea's bill, which he consented to separate from his omnibus measure revising the Civil Aeronautics Act

Main difference of opinion that showed up in the hearings was between the large cities, which wanted to obtain and administer large amounts of federal aid money, and the states, which had the same intentions. Total federal aid proposed in the bill is $650,000,000, a five-year allocation

Commerce Secretary Henry Wallace supported the legislation "to ease the shock of deflation of our huge wartime aircraft industry", and to strengthen postwar economy and utilize our warborn aviation resources



MAKING THE WCK'COPTER

First photo of WCK copter Flymobile developed by Curtiss Wright industries, Los Angeles gives detailed skeleton view of new craft, which is scheduled for test flights as we go to press A single seater, it is of metal construction with wood fairing strips and fabric covering A 90-hp Franklin engine turns 25 ft dia four-blade coaxial rotor at an estimated 325 cruising rpm, giving craft top speed of about 95 mph. Gross weight is approximately 1 100 lb. Design of three-wheel landing gear seems to indicate that Flymobile is also roadable

The Feeder Airlines Assn advocated extension of short-line services, with airports to accommodate them The U S Chamber of Commerce warned against the provision which would permit municipalities and other project sponsors to deal directly with federal authority E E Wilson Aero Chamber president said the country should provide opportunity for returning airmen primarily by making the fields attractive as personal enterprises

★ SPOT CHECKING ★

It's no longer the Aero Chamber—for at press time came announcement that aviation's veteran national association has changed its name from Aeronautical Chamber of Commerce of America to Aircraft Industries Assn of America. Since membership broadly includes aircraft, engine, propeller, and accessory makers, it is held that new AIAA designation is more representative of body, also past confusion with chambers of commerce will be avoided by the change in name.

Aviation Writers Assn. conference in Chicago was a special 1 month, with 56 aviation writers and editors registered for three-day program A highlight was group's Lake Michigan trip aboard trainer aircraft carrier Sable for close-up observation of deck landing and takeoff work through courtesy of Naval Air Primary Training Command Further, ATSC Supply Div. flew special B-29 components designated by AWA members, from various national bases to demonstrate how combat craft needing parts are supplied in snap time With Illinois and local groups as hosts, following were among organizations presenting programs PCA United Aircraft Curtiss-Wright Boeing TWA Martin, Aeronca, PAA, Popular Science Publishing Crowell Collier Publishing Goodyear Sperry Minneapolis-Honeywell, Alcoa In addition an international high-spot was provided in special discussion of [illegible] by Billings Air Marshal Collyer In business session AAA named Maurice Hoffs *Chicago Times*, as new president, James Strebig AP, first v p Phil Andrews Andrews Publishing second v p Devon Francis Popular Science Publishing secretary and Leslie Spencer McCann-Erickson advertising, treasurer Retiring prexy George Haddaway of *Southern Flight*, assumes duties as head of board of governors For supplying air transportation which made conference possible Troop Carrier Command was particularly hailed by membership

Aircraft Engine Research Laboratory, NACA's $24,000,000 building installation at Cleveland Airport was initially opened to press when AWA group flew in from Chicago following association conference In a program notable for its explicit presentations members saw highlight work of laboratory Included in demonstrations were fuel investigation on B-24 turbine materials research impinging jets carburetor icing bar, fuel vapor loss study, exhaust valve cooling research compressor impeller stress studies, axial flow compressor, combustion investigation with NACA high-speed camera, jet propulsion combustion research fuels synthesis, altitude wind tunnel, icing research tunnel intermittent ram jet propulsion and jet propulsion engine research Prior to laboratory tour, group visited Thompson Products plant

AAF has released some data on fire bombs, being used so effectively to burn out Jap industry Included are M69, a 6-lb. missile filled with jellied gasoline dropped in airmine clusters opening in mid-air by means of a time fuse M47, a 100-lb. bomb dropped singly, also containing jellied gasoline which is thin-walled and scatters chunks of fire 40 yd., M76, or "goop" bomb, a 500-lb blockbuster which in addition to jellied gasoline, combodies powdered magnesium, liquid asphalt and other ingredients which on impact combine to form a synthetic lava, and M74, a 1d-lb tubular type which spews synthetic lava, combining jellied gasoline, magnesium powder, white phosphorous, and other ingredients and which with a piston like operation expells gobs of fire 65 yd

Sweden has purchased 50 North American P-51 type warplanes through an arrangement with U S government, craft being recently flown from British bases to Bromma airfield near Stockholm NAA company is supplying technical assistance through a field service representative.

A new super-strength Alcoa alloy designated 75S is now being used on Boeing B-29 Superforts Having a yield strength in excess of 60,000 psi, alloy is used for craft's upper wing skin, making possible a reduction in material thickness that saves about 400-lb per plane

Stinson announces several new postwar airplanes: A two-place low-cost craft for short cross-country hops, personal flying and instruction, a three-placer, a five-seat ultra-modern high-speed type, named Skycoach, and a twin engine five-six-place junior executive type with general performance described as equal to present airliners.

TWA's Brig Gen Thomas B Wilson told AWA members at Chicago that a "human reconversion" program will be necessary after war He stated that war inconveniences priorities, and equipment shortages have incurred displeasure of many

ONE of the advantages of magnesium alloy sheet is the unusual depth to which it may be drawn *in one operation* at an elevated temperature. This wing gun fairing is a good example. The overall length of the fairing is 35". The width at its widest point is 10½". The depth of draw is 11"

This unit was produced in one draw at a temperature of 550°F, using heated rools, on a 200 ton hydraulic press All experienced sheet metal men will recognize the exceptional nature of these results, which could scarcely be duplicated with other structural metals

To the high strength weight ratio of magnesium alloys, and their excellent weldability and machinability, can be added the speed and economy with which deep drawn shapes can be produced. In large-scale production, this feature alone may dictate the use of magnesium.

Revere magnesium sheet is available in three alloys, either hard rolled or annealed, providing a wide range of mechanical properties and working characteristics Magnesium is available without restriction, subject to the prior claims of war production Your priority rating will help to expedite deliveries For full information on magnesium alloy sheet and plate, tube, rod, bar, extruded shapes and forgings, call the nearest Revere office. A Revere Technical Advisor will gladly consult with you.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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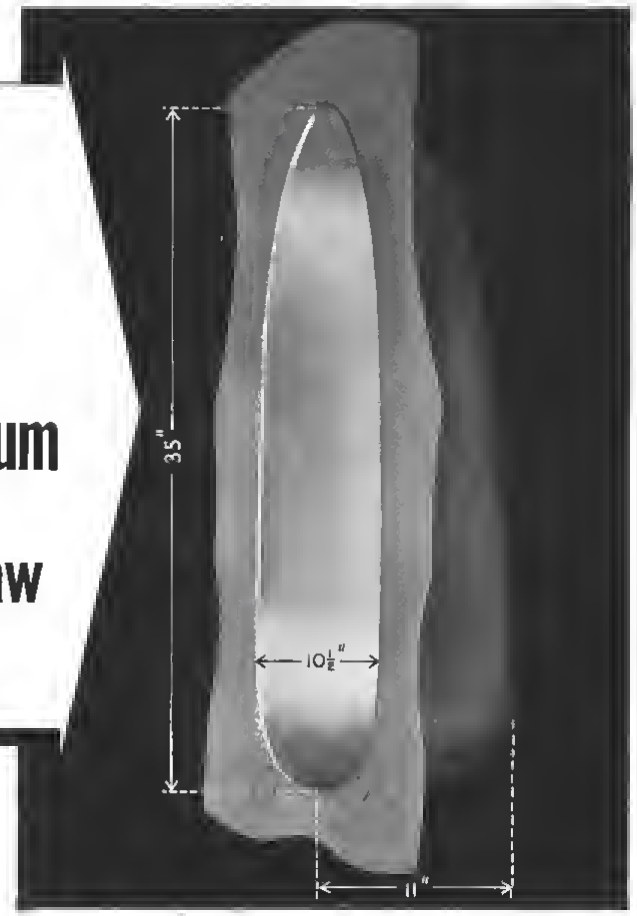
FABRICATORS OF COPPER, BRASS, MAGNESIUM, ALUMINUM, BRONZE & STEEL

Made of REVERE Magnesium in 1 draw



The deep drawn magnesium shape as it comes from the press Fabricated by Brooks & Perkins, Donovan Building, Detroit, Michigan

customers, and that a reselling job will have to be done with personalized service restored to previous standards.

Lets Milo Burcham, former Lockheed test pilot, has been posthumously awarded Air Medal for meritorious achievement while participating in aerial flights from 1937-1944.

AAF will soon put into use new test laboratory at Wright Field wherein temperatures of —110 deg. F. can be obtained in order to learn about weatherproofing fighting planes for action in world's coldest regions. Unit will consist of four test chambers using three types of refrigeration compressors.

Turbo-electric propulsion was subject of talk by Austin F. Trumbull, USN, representative with Douglas Aircraft, at recent SAE meeting. He stated that preliminary engineering investigations suggested that aircraft powered by electric-turbines might offer substantial savings in weight and power due to reduced drag and more efficient propeller locations. Another prediction was that within 6-10 yr. electrical loads of planes will range up to 30,000 kw.

It's stated that every 10 min. a military plane takes off from a West Coast airport for a trans-Pacific flight and that every 15 min. an AAF cargo or passenger plane heads eastward over Atlantic. During peak operations in CBI, planes have passed over 'Hump' only 3.9 min. apart.

Lockheed reveals that company submitted a jet-propelled fighter design to AAF in 1941, but need for production of conventional types delayed project. Also revealed is fact that P-59A is larger and heavier than XP-80, which was powered by a British designed jet engine.

AAF states that more than 800 ATC craft will fly in and out of Miami Army Air Field as part of ATC's job of flying 50,000 overseas veterans to U. S. each month. C-47's are to land at field every 40 min. on a 24-hr. basis. It is estimated that craft will use more than 1,000,000 gal. of gasoline and 80,000 gal. of oil in one month.

New 50-cal machine gun, capable of shooting 1,500 rounds per minute, has been perfected by Army Ordnance and Frigidaire div. of GM. Fire rate is increased 50% over previous types.

Great interest of public in aviation bidding fair for postwar business, was indicated by two-day War Bond air show at Westchester County Airport, N. Y., which drew more than 40,000 spectators.

Fourth transcontinental airline went into operation when NWA came into La Guardia Field, N. Y. from airline's former terminus at Milwaukee. NWA also hopes to establish routes from Seattle to Hawaii and to Orient via Alaska.

Atlantic security regulations have been relaxed so commercial airplane arrivals and departures are now made public. FAA is permitted to reveal that company transported $1,000 was passengers since Dec. 7, 1941; flew patrol bombers for Navy; provided Navy with flight engineer training programs; gave enemy reconnaition trainings and flew 3,000,000 mi. on special missions.

AAF is now operating a regular service from Maine to Stockholm, Sweden.

ATSC's N. Y. Regional Office, Eastern District, at 1 Park Ave., N. Y. C., has been closed and functions and personnel transferred to Eastern District Hq., 67 Broad St., N. Y. C.

Jet-propelled transports traveling at over 1,500 mph at altitudes of 100 mi. were predicted for 1955 by Lockheed's Chief Engineer Hall Hibbard.

Britain's government believes that responsibility for design and development of airplanes rests entirely with aircraft industry says G. M. H. Nash of British Ministry of Aircraft Production.

With engines running antitime to keep planes facing into wind a group of Martin P6M Mariners recently rode 8-ft. waves and bucked 100 mph winds for 20 hr. to ride out a South Pacific tropical storm at moorings. Crews aboard had to "fly" craft for storm's duration.

Trans-Atlantic waiting list of about 2,500 passengers has been built up by PAA since 1944.

Further developing school's navy program Purdue offers short courses this summer for high school teachers.

A shortage of technical and scientific men will handicap postwar expansion of industrial research, stated R. J. Dearborn, general rank posthumously to late Col. William "Billy" Mitchell. Legislation has been sent to House for approval.

AAF's A-14 oxygen mask is now also used during ditching. Experiments have shown the mask prevents strangling due to rough water. It enables crewman to swim under water beyond oxygen fire, prevents face burns and breathing of fire, makes possible successful handling of unconscious persons under water, and permits escape from submerged crashed planes.

Philistines: To serve aviation in Latin America, Turco Products, Los Angeles, offers 36-page booklet in Spanish for airline operators and maintenance engineers. Essentially a service manual, booklet gives information on modern chemical methods on exterior plane maintenance, engine overhaul, corrosion prevention, plating operations and airport maintenance and is available without cost on letterhead request. "Wartime Technological Developments" is title of a report prepared by U. S. Bureau of Labor Statistics for Senate Military Affairs Subcommittee. Aviation developments cover 98 pages and added sections cover aviation gasoline and metals. Included are short-cuts and new methods of manufacture in airframe, engine, propeller, and glider fields.

N. Y. C. Dept. of Marine & Aviation has issued attractive booklet containing plans, data and illustrations of new Idlewild Municipal Airport. Dept. of Labor is issuing a series of safety charts depicting work hazards and dangerous work practices. Thus far this year monthly series has covered: Industrial trucks, engine lathes, band saws, abrasive wheels and shapers, respectively. To come in following months will be charts on ladders, wrenches, some electric hazards, arc welding equipment and screw drivers. Charts are available from Government Printing Office Supt. of Documents, Washington 25, D. C. at 5¢ per copy.

Errare humanum est. Due to an unfortunate similarity of sizes of plates, photo of Sikorsky R-6 helicopter was mistakenly printed on page 125 of June issue instead of intended flight shot of Aeronautical Products, Inc., helicopter. In May 1 Aviation People page, purported photo of John L. Cahill, president of Firestone Aircraft Co., was instead photo of D. Anderson, company's new vice-pres., this error being caused by a misconstruing of photos and captions. . . . New Product Item No. 71, page 238 of our April number incorrectly specified Arc Equipment Corp.'s new drills as being electric. Correctly they are pneumatic.

NEW SEAHAWK SPOTTER JOINS NAVY

Here is Curtiss Wright SC-1 Seahawk, single-seat single-float seaplane designed especially to operate with our fleet as a gunfire spotter and reconnaissance plane. Power plant is a Wright Cyclone 9, giving craft nearly three times horsepower of predecessor types, and Navy further says new SC-1 is twice as fast, can fly higher, farther, and has better armament than any previous models. Wing flaps and full span automatic slots bring craft's landing speed down to almost that of Kingfisher or Seagull. Curtiss four blade hollow steel propeller is used. As a facility for search-rescue work, there is room in fuselage (behind pilot) to carry one man, and additional feature is bomb bay in fleet. (U. S. Navy photo)

NIPS' ONEWAY EXPRESS

In this unusually clear photo are revealed design characteristics of Japs' notorious rocket-propelled "Baka" bomb. Found abandoned on Okinawa's Yontan airfield, odd craft has wingspan of about 16 ft., a length of 19 ft., weighs about 1,000 lb., and seats a pilot specially trained in suicide tactics. Usually carried to scene of action beneath a twin-engine Betty bomber, it is launched several miles from target and then directed by occupant against objective at speeds ranging up to 600 mph. Bake has proved to be one of most effective weapons in Japs' arsenal, even though high ranking Navy spokesmen state that only an estimated 1 to 2% of flying missiles reach targets. (Press Assn. photo)

AMERICA AT WAR

Aviation's Communique No. 42

More than half a year has passed since air war started on Japan from the Marianas. The power is on; it is hurting the enemy, and it will hurt more when Nippon gets 2½ times the tonnage that was dropped on Germany, whose area was several times greater.

Japan's desperate bid for defense with suicide pilots cannot slow the Allies, according to Vice Admiral Marc A. Mitscher. He said only one in a hundred planes that attack Navy craft ever get to their targets. Nevertheless, this form of attack has damaged many ships, killed many men and required some redesign by Navy.

Navy pilots' reports that the Japs had come up with new fighters out-speeding the Corsairs, and with superior tactics, are discounted by Navy spokesmen. Tired pilots in tired planes, when attacked by a fresh enemy group, they say, often get pessimistic impressions. Even if the Japs had superior new designs, they could not build enough of them to have much effect. Furthermore, new and superior designs are on their way to our Navy air arm.

Pres. Truman, in his recent report to Congress, estimated Japanese air power at something over 3,000 combat planes. He probably means frontline equipment available for action. This would compare with German's top available air strength of about 5,000 planes. The President calculated Japan's monthly production of aircraft at 1,350

to 1,500 per month at this time, despite a half year of American air attack on factories.

The President said his military policy is (1) to pin down Jap forces where they are, divide them and destroy them piece by piece, (2) concentrate overwhelming power on each attacked segment, (3) use aircraft, ships, armor and artillery massively to save life, (4) apply relentless pressure so that the enemy cannot rest or reorganize.

Secretary Forrestal says Navy has three main tasks: (1) deliver men and supplies needed for present and future operations; (2) seal off the areas of attack in advance, (3) open up, support, and supply the beach-heads.

Many of the bombardment groups have already been moved from Europe to the Pacific. The powerful Eighth Air Force, which with the British RAF spread destruction over Nazi-land, will move across, and will be armed with B-29's, P-51's, P-47's, P-80's, and others now in the taper off stage. The British have moved in with carrier task forces. U. S. Navy reveals it has 28 carriers and 65 escort carriers in action (less those under repair) and is building more under forced draft.

Because Japan's production is extensively piece work in homes, whole cities are being systematically burned down. Scouts are already photographing smaller cities and towns. Experience has shown that, in many cases, fire keeps plants down longer than demolition by bombing; it warps machines so they can not be re-installed. But fires do not burn well in certain kinds of weather, and explosives continue a major weapon.

Okinawa, taken at great cost of time and life, will be the most powerful advance base in the history of war. It is only 350 mi. from Jap mainlands, 872 mi. from Tokyo, short distances for late model planes. The island group can accommodate massive Army and Navy air forces.

The Japanese are already assuming the Nazi "fortress" defense attitude. Their navy has failed. Now their air forces are weakening, and the suicide technique is not improving their situation. Creditable thinkers believe the enemy may collapse in a matter of months under punishment from the air. But confidence in their hard-driving land forces, so long as those forces can get weapons and supplies, may keep Japan going for a long time.

★ CANADIAN NOTES ★

By James Montagnes

Since inception of War Assets Corp. fiscal autumn sales of Canadian surplus aircraft and equipment have totaled some $2,500,000 (to May 10). In this period 379 aircraft were sold for $1,800,000, of which 284 planes went for service outside of Canada. Aircraft equipment brought approximately $1,000,000. Recent sales included 8 Lockheede 8 Ansons, 17 DH Tiger Moths and 2 Grumman Goose amphibians. These planes sold for $135,298 with seven going outside Canada.

Vancouver airport is to be enlarged as Canadian terminus of a Pacific route which is to meet an Australian service at a point somewhere in Pacific according to W. F. English, v-p of TCA, which will operate route.

RCAF's personnel is being cut down from about 170,000 to 100,000. Latter number will be used for RCAF's participation in Pacific war, occupation service in Germany, and administrative work in Canada.

A central Canada air conference was held at Winnipeg recently to check with municipal authorities regarding postwar building of airports, air services, and need for immediate planning. Conference was called by Winnipeg Board of Trade, and speakers from Canada and U. S. discussed air problems with 400 municipal delegates who attended. Policy on disposal of surplus war-training airfields was urged on Ottawa. Delegates were informed of airfield needs of more than 400 Dominion municipalities, none of which has airport facilities of any kind.

★ CALLING NAMES ★

Bowman H. Otto, pres. of Otto Aviation, has been elected pres. of newly formed N. J. Aviation Trades Assn. **O. P. "Ted" Hebert** became v-p., **Walter H. Laudenslager,** secy., and **Sanford W. Bleckleton** became treas. **George Lambrex, Jr.,** and **Joseph Schwende,** with officers, comprise Board of Trustees.

John N. Gladden became pres. of Kinner Motors, succeeding **Earl Herring** who resigned to look after other interests.

Lee Miller was appointed mgr. of flight operations at C. W.'s Columbus Ohio, plant. **Ed Gray-son** became new staff asst. in company's sales, publicity and promotion dept.

PAA appointments: John E. Yerex as regional mgr. for New England area, **Edmund L. Buckley, Jr.,** as district sales mgr. for San Juan; and **Edgar D. Hensley** as acting district sales mgr. in Los Angeles and South western states.

R. L. Mussen has been made Convair's asst. div. mgr., and **F. L. Farrell** chief of contracts.

Joseph A. Uhl has been appointed asst. to pres. of CAL, and **Donald A. Duff** became exec. asst. in charge of airline's traffic and sales.

Ralph B. Smith was elected secy. of Menasco Mfg. Co.

TACA appointments: Herbert A. May, Frederick M. Peyser, Webster B. Todd and John M. Lockhart were elected to board of directors; Harry Van Der Garst became purchasing agent, James S. Hunter was made new traffic mgr. at Miami and Henry T. McGee joined company as gen. purchasing agent.

William T. Piper, Jr., became chairman, and **Carl Friedlander** vice chairman, of ACCA's PAC.

Beverly E. Howard, pres. of Hawthorne Corp., has been named a director of All American Aviation.

Solar Aircraft appointments: E. E. **Binger** became director of industrial relations of company.

(Continued on page 229)

★ OBITUARY ★

Laurence La Tourette Driggs, lecturer and author on aviation subjects. Learning to fly as early as 1914, he later was attached to RAF headquarters, and following World War I he investigated German aviation activities. He was organizer and first president of American Flying Club, and he also organized and commanded the New York National Guard 102nd Observation Squadron.

GIVE HIM ENOUGH ROPE

... end a Curtiss Helldiver pilot can double in the job of plane towing, as was recently demonstrated by Nevy men attached to Manteo Naval Auxillery Air Station, N. C. A Grumman Widgeon required a change of engines, but facilities were not available to handle job at base. So engines and preps were removed from Grumman, eye belts were installed on ends

of two prop shafts, a "V" harness and tow line were attached—and 325 mi. sky hent to Johnsville, Pa. was made without mnch incident in 2 hr. 35 min. On arrival, Widgeon pilot cut loose from Helldiver end made a dead-stick landing.

THE WASHINGTON WINDSOCK

By BLAINE STUEBLEFIELD

While Jap war factories are concentrated, making good bombing targets, millions do piece work in homes, which are being burned by AAF with new and fierce incendiaries.

One wishful rumor was true. Cities of the islands are highly inflammable. But each attack requires long careful planning as to proportion of fire and demolition bombs, and timing since last attack. Many things can go wrong; overcast, rain, wind, even humidity dampens fire to an amazing extent. Cold nights, though, enhance burning.

Leaders in Government and armed forces differ on how long air attack should continue before invasion. One group wants to take time for air war and save lives, other would wade in and get it over. Many believe aviation can batter the Japs down, but are wary after the German setback.

Balloon bombs from Nippon cannot hurt U. S. much, but their long range, silence, cheapness and capability of creating public tension make them interesting possibility for use where prevailing winds distance and density of population are favorable.

Hoorays for victory over Germany are held by some to be quite out of place. Fact that it took most of other military powers in the world to beat a little guy with a nutty gleam in his eye, and a country smaller than Texas, is sinister indeed, and deserves serious thought.

Army's revision of aircraft production schedule indicates confidence Japan can be polished off with progressively improved versions of existing designs, mainly four fighters: P-51, P-47, P-38 and P-80, and the B-29 and three transports: C-47, C-54, and C-46. Both Army and Navy are still developing new stuff, just in case.

Many leaders in non-scheduled aviation feel that the various groups must unite in presenting their claims to Washington. Scheduled air transport and military aeronautics demonstrated convincingly what can be done by coordinated effort.

An excellent war record and a promising future are the airlines' reward for their past years of effort and fair dealing. They are coming out of the conflict with organizations intact, with freedom of enterprise, and with their competitive forces still working.

Army Plane Output Seen Dropping 17,000 Units Via 30-10-5 Cutback Plan; Navy Levels Pegged

. . . Production status noted on 10 types . . . Gage late developments on surplus craft front . . . May output 6,354 planes . . . Check civil plane picture

Army's announced combat aircraft cutback of 30% during the last half of 1945, and 10 and 5% in the two halves of 1946 can be drastically changed at any time. Anticipated progress in the war against Japan probably will bring additional large stop orders.

Meanwhile Navy's aircraft requirements continue at current levels. New aircraft carriers are constantly being commissioned and taking on new airplanes. The enemy at this stage of the war is able to inflict serious losses on Naval aviation.

On the basis of airframe weight, production for Army in the second half of 1945 will be about 70% of weight produced in the first half. Production in the first half of 1945 is projected to drop to 60%, in the second half to 55%. The total reduction in units is seen as about 17,000 airplanes.

Many Government military and airplane industry officials have complimented the industry for its important part in bringing Germany down. E. E. Wilson, president of the Aeronautical Chamber of Commerce, said the industry is ready to begin production of civilian transport and personal airplanes as soon as the national interest will permit. He called for continuation of aeronautical research at a high level. Donald Douglas, president of Douglas Aircraft, stated that the industry has built about 300,000 airplanes since President Roosevelt called for 50,000 craft in May of '40.

Gen. H. H. Arnold, chief of the Air Forces, praised the quality and quantity of aircraft produced and said they had played a vital part in winning the European war. He said that tactical and strategic requirements have changed. The airplane attrition rate dropped in Europe as the Luftwaffe weakened and many planes sent there will now fight Japan. Stop orders are due chiefly to curtailment of lend-lease deliveries.

Production Status Noted On 10 Types

Detail of cutback orders may change at any time, but it serves to show present air war trends. Nearly all Army combat types and nearly all U. S. cities building airplanes are affected. At this writing the production schedules of aircraft engines and propellers were being revised.

Consolidated B-32: To be discontinued at once at San Diego, and to be tapered at Fort Worth to termination by close of 1945.

Boeing B-17: To be tapered to about one-fourth present rate at Douglas Long Beach by this Fall. At Lockheed Burbank, production will terminate this Fall chiefly to accommodate P-80 output.

Boeing B-29: Present production rate to increase for a while and then to be stabilized during last part of this year. Each plant producing B-29's will incorporate all modifications, employment will not be affected.

Douglas A-26: Continuing at Long Beach and tapering to termination at Tulsa by Jan. 1.

Bell P-63: To be cut by July and terminated in September, target trainer (shot at with frangible bullets) unchanged this year, reduced next.

Lockheed P-38: Tapering to zero by November. Consolidated at Nashville terminates after June.

Lockheed P-80: Will continue unchanged at Burbank; production at North American, Kansas City, has been canceled.

Douglas C-47: Tapering to half present rate at Oklahoma City by year-end, to continue on that output level into the year 1946.

Beech C-45: Continue at current rate to Fall, then taper to about half where it will stand into 1946.

Curtiss C-46: Now ending (June) at Louisville. St. Louis is also terminating, but will continue parts production. At Buffalo is continuing unchanged at this writing but is to level off at two-thirds after August.

Gen. Arnold said that long-range types are wanted for the war on Japan. Army's statement does not mention the Consolidated B-24, North American B-25, P-51, Republic P-47, Martin B-26, and some others. Presumably no cutbacks have been planned for the new models of North American P-51, or for the Douglas C-54. The B-24 is already out at San Diego, and is terminating July 1 at Willow Run, where a unit has been rolling out every 55 min., making good Ford's objective of one per hour. Boeing at Renton is producing six B-29 Superfortresses per day.

Although man power is still tight in several plants it is expected that layoffs for the industry as a whole may reach a percentage equal to the cutback in output.

Gage Lists Developments On Surplus Craft Front

Confused direction of surplus aircraft disposal continues in Washington. Reconstruction Finance Corporation has now placed all surplus property functions under Hans Klugsbrunn, Defense Plant Corporation vice president who has been heading the aviation part of the program. Joseph P. Woodlock is executive director. The Surplus Property Board now is directly under RFC, not DPC. James A. Garfield became deputy director, in charge of aircraft disposal.

Disposal of military aircraft overseas has been taken from the Foreign Economic Administration and is under the Army-Navy Liquidation Commission. ANLC was to have had aircraft, among other surplus war goods abroad, in the first place, but it was outmaneuvered by FEA. ANLC exercises policy-making powers, whereas the domestic Surplus Property Board is merely an administrative agency, whose policies are made by RFC, along with the Army and Navy.

Development by the Aluminum Co. of America of a successful process for salvaging pure aluminum from airframes (in a caustic soda bath which dissolves aluminum and leaves other metals untouched) may result in Government decision to return all surplus warplanes to this country for conversion into an aluminum stockpile for any future emergency.

An estimated 30,000 schools and colleges appear to be eligible under an SPB regulation to purchase surplus military planes for educational purposes at prices ranging from $350 for B-17's to $100 for dive bombers, $1, $2 and $3 for indicators, brake assemblies, and carburetors. Shipping weights are stipulated and shipments are direct, when possible, from nearest storage point.

In general all desirable light liaison planes have been sold; there are plenty of less desirable trainers still on the market, however.

In the transport category only the Lockheed Lodestars (about 70) are available. Combat airplanes are useless for most civilian needs.

MAP AIRCRAFT STANDARDS PROGRESS

Members of National Aircraft Standards Committee are seen here at recent ninth semi-annual meeting in Holly wood, sponsored by Aero Chamber of Commerce. Standing, left to right, are: W. V. Stackhouse, North American; J. Townsend Hughes, L. J. Catlin, Douglas; J. F. Shirtzinger, Douglas; V. G. Mellquist, ACCA; G. W. Vaughman, Cessna; T. A. Erbe, Convair; W. H. Korff, Lockheed; D. W. Beck, Douglas; J. F. Cramer, Boeing; C. E. Sheckells, Douglas; E. A. Pinger, Convair; V. Tini, Hughes; E. Dudley, C. W. C. T. Torresen, North American; C. R. Watson, Beech; J. H. Wood, Ryan; J. Perina, Republic; W. E. Buffe, Goodyear; J. F. Hammond, Boeing; C. Sardon, Jr., Convair; E. H. Babel, Northrop; C. Schindler, Fairchild; G. T. White, Convair; H. R. Leader, Bell; C. E. Heywood, Vought; J. B. White, Lockheed; R. P. Roepke, McDonnell; E. W. Norris, ACCA; and M. P. Cameron, Lockheed. Seated, left to right, are: E. D. Graham, North American; T. P. Hearne, Ryan; Flt. Lt. D. G. Moffitt, RAF, British Air Commission; G. H. Nash, British Ministry of Aircraft Production; J. A. Drankewski, Fleetwings; J. T. Thompson, Martin; (NASC national chairman) G. M. Aren, Northrop; H. W. Zipp, Boeing; Lt. Comdr. J. J. Tigert, Aero Board; Lt. Col. G. R. Gallard, Aero Board; and W. V. Boughton, Douglas. (Hed Lewis Associates photo)

May Output: 8 354 Planes

Output of planes in May totaled 8 354, surpassing by nine units the number scheduled for the month. This was the third month in which the quota had been topped. In comparison April production was 6 412.

The drop from the previous month showed the influence of the ending of the war in Europe, with consequent lessened demands for certain type craft not slated for use against the Japs.

May output of bomber craft hit 2 189, 15 over the quota of 2 153. Total of trainers was 184, against 190 scheduled. On the other hand, fighter and reconnaissance craft summed to 3 018, 11 under the 3 030 called for. Transport types missed the 638 goal when but 517 were made, and the 395 special purpose planes were 10 short of the scheduled 378.

Check Civil Plane Picture

Aircraft manufacturers are free, under an Aircraft Production Board (WPB) order to begin to produce equipment for the airlines to such extent as does not interfere with the war. Great credit went to Henry Nelson, director of the Aircraft Division of WPB, and to manufacturers attending a Washington meeting, for securing the authorization, which carries an AA-2x priority. Army and Navy approved the program.

The airlines had asked for 331 planes; the figure was later raised to 364—205 four-engined and 159 two-engined units. Some are to be delivered in the last quarter of 1945, the rest in '46. Eighty percent are wanted by June 1946. RFC is authorizing the use of government - owned tools and other facilities in production of the planes.

Production of light airplanes was authorized on May 17 by revocation of WPB Order L-41—that is, to such extent as does not hinder the war effort. There is no automatic priority for lightplanes as for transports; the manufacturers have only "spot authorization" which may be withdrawn at any time. Priority assistance is provided for modification of surplus planes sold by RFC, but not many desirable types except for training purposes are offered.

★ KROW HOWS ★

High-frequency low-voltage ignition by P. R. Mallory, Indianapolis, is said to fire evenly under extreme conditions of dirt and oiling. System has been tested with good results at 50 - 000 ft altitude.

Synthetic rubber protective strips installed by U. S. Rubber Co. on helicopter rotor blades are reported by Coast Guard to prolong rotor life indefinitely, under rain abrasion as against damage after 10 min for unprotected units.

Mike control switch installed in gun mount on B-17s by UAL is estimated to have saved over 21 000 man-hours per year in wiring time and servicing.

Electronic sequence timer developed by ATSC after being told it was impossible, will make six exposures in 0/10,000 sec., reports Wright Field.

Using phenol formaldehyde resin adhesive by Redmond Products & Chemical Co., moulded plywood aero lifeboats weighing 3 200 lb. are being made by Higgins Plastics Co., of New Orleans.

Selenium rectifiers with 85% efficiency are now being designed by G-E for converting single- or polyphase current to d.c.

Clamps now being used by Glenn L. Martin instead of burlap for plaster mold corners have resulted in considerable time saving and increased efficiency.

★ FOR THE RECORD ★

Republic Aviation has opened a permanent N Y C. engineering office at 42 Broadway in order to speed up essential experimental projects.

Alabama Institute of Aero has sold interests in Hargrove Van De Graf Field to Dixie Air, Inc. Field houses a fixed base operator and has a resident flight school for young women. Raymond Collin will be in charge.

Trimount Instrument Co., 67 W. Van Buren St., Chicago, has been licensed by Convair to build Convair-designed 55-tube inclined tube manometer for wind tunnel research. Divisions on instrument's scale are horizontal, from 1-10 in calibrated in tenths and stated to make possible very high accuracies. Walls are aluminum or stainless steel and manual tube and vernier arrangement is said to be leak-proof. Instrument is relatively light, compact and portable.

Sendix Aviation Corp., Pacific Div. has opened a sales-engineering office in Continental Building, St. Louis, Mo. Harold W. Bailey and William P. Harrisen have been appointed sales engineers in new office.

Zimmer-Thomsen Corp., 28-05 Review Ave., Long Island City, has changed corporate name to Thomson Industries, Inc. Company makes Iso-Rev constant-speed propellers, Thriftmaster multiple spindle drill-heads and Ball Bushing longitudinal reciprocating bearings.

GE's research laboratory will be enlarged by a new building costing $4,000,000 in suburban Niskayuna, about four-and-a-half mi. from main plant and offices in Schenectady, N. Y.

Rockford Clutch Div. of Borg-Warner opened new engineering laboratories in Rockford, Ill.

Gothard Mfg. Co., Springfield, Ill., is having a new plant built which will furnish enlargement of company's engineering and research departments in addition to increased manufacturing space. Company makes pilot light assemblies for electronic and electrical equipment, and appliances.

Buchanan Research Laboratories, Inc., 2 West Jersey St., Elizabeth, N. J., is newly formed organization headed by Stephan N. Buchanan. Concern does research and development in radio, telephone, television, aircraft and commercial wiring uses.

The Instrument Society of America is a new national society formed to advance arts and sciences connected with design, manufacture and use of instruments. Elected pres. was A. F. Spetty, while C. E. Kovan was made v-p. G. E. Fry became treas., and Richard Rimbach was made secy. Office of secy. is society's temporary office and is at 1217 Wolfendale St., Pittsburgh, Penn.

Linear, Inc., is new name of Linear Packing & Rubber Co. State Rd. & Levick St., Tacony, Phila., Pa. Concern makes hydraulic seals used on airplane hydraulic systems.

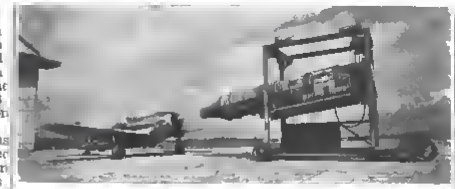
KNILM has located new offices at 521 Fifth Ave., N. Y. C., room 1008.

New Aviation Products Div. has been formed by Goodyear Tire & Rubber and R. W. Richardson was appointed mgr. Tire, wheel and brake sales for airplanes, formerly part of Aviation Sales Div. of Government Sales, and former Aviation Products Dept. will become part of new division which combines all related activities of company.

O. L. Woodson Co., 714 W. Olympic Blvd., Los Angeles 15, is newly formed industrial service to develop products, production methods, plant facilities and general management. Organization has been associated with Northrop, C-W, Chance Vought, Bell and Ryan.

GE plans to establish a new base at Schenectady County Airport, N. Y., where company's flying laboratories will test scientific and mechanical developments, including jet engines and gas turbines for airplanes. It is stated that work on a hangar and ground laboratory will begin immediately. Building will be 150 ft. wide, 185 ft. long, and 40 ft. high at center.

Allied Appliance & Plastic Co. is new name of Allied Appliances Co., 1014 N. La Brea Ave., Los Angeles 38. Company, which specializes in making aircraft and automotive valves, fittings, and other automatic machine products, has added a plastics div. to design fabricate, and mold parts. Chief is R. B. Gutsch.



NACA'S "OUTDOOR WIND TUNNEL"

This mammoth portable blower is used to send high speed airstreams into revving power plants of chocked-down aircraft, thus simulating test flight conditions without need for plane leaving ground. Massive unit seen here in action with Republic P-47N, is capable of producing 250 mph airspeed. Blower's ten action enables operation of test engines at maximum takeoff hp., accordingly eliminates dangers of takeoffs with untried engines. Furthermore, blower is invaluable research tool, making possible numerous studies such as of cooling of fully installed power plants. NACA's Aircraft Engine Research Laboratory at Cleveland initially revealed this equipment in press on occasion of recent inspection tour by Aviation Writers Assn.

★ ASSEMBLY LINES ★

Convair has made 9,400 Liberator B-24s. Of total, 8,725 were made at San Diego plant and 2,745 were built at Fort Worth. In addition company turned out spare parts equal to 1,185 more bombers. During war, company has made 98,280 planes counting spares, representing 870,000,000 lb. and 14 different types.

Lend-Lease U. S. has shipped 18 300 planes to Russia and 5 300 to United Kingdom. Total of $5,518,614,000 was spent on shipment of planes, engines, and parts to all of Allies.

C-W stated corp. will close St. Louis plant and concentrate production at Buffalo and Columbus. Wright Aero's schedules will represent, by next June, a 50% increase in engine production over level of early this year. More than 123,000 Cyclones has been built for European phase of war.

Northrop's veterans' hospital program has achieved 100,000 hr. of work without a single industrial accident or even a first aid injury.

Douglas has turned out 10,009th DC-3 transport, with all but 800 made since Pearl Harbor. Craft are now only built at Oklahoma City plant.

Willow Run plant is stated to be turning out a complete B-24 every 55 min. of working time, and recently passed a total mark of 8,500 of craft. Production is now on one eight-hour shift.

Total of 10,000 Vought Corsairs have been built. Vought has made more than 7,000. Goodyear has made over 3,000, and 735 were built by Brewster.

Boeing's Seattle-Renton plants expect to reach peak production in June. As Superfort this Summer, Renton plant is turning out six bombers a day.

Georgia ATSC depot has reduced time to overhaul such P&W R-2800 engine from 350 to 240 man-hours per engine, has cut time to overhaul Boeing B-17 by 2 125 man-hours. Depot reports annual savings of more than 2,850,000 man-hours have been made, plus $180,000 yearly in operational costs through changes in policy on construction and repair work.

Detroit Gear Div. of Borg-Warner has made 250,000 aircraft vacuum pumps since Nov. 1941.

Airlines Get AA-2 Priority for New Planes; Authorization Includes Component Makers

. . . C-54 released for tests . . . ATA conference gets special traffic sections . . . AAF to release pilots for airline jobs . . . NE Phila. airport re-opening.

Airlines have been authorized by APB to order new planes with assistance of an AA-2 priority. Manufacturers are free of all restrictions on delivery of airliners except that military requirements must come first.

A schedule submitted by operators during a Washington meeting which resulted in the agreement calls for 159 two-engine planes and 205 four-engine units, but as operators are expected to deal individually with producers the schedule may come to have little meaning.

It is expected that a few new two-engine planes can be delivered this year, but no four-engine equipment can be turned out until next year.

Henry Nelson, director of WPB's aircraft division, was credited with a leading part in the agreement worked out with the Army, Navy, and WPB. Manufacturers called to Washington to take part, and the Aircraft Manufacturers Industry Advisory Committee, were surprised at the promptness and extent of their success.

Government-owned facilities and tools will be used in production of the airline planes. Cooperation of the RFC and of the Office of Surplus Property seems to be assured to that end.

The authorization, signed by WPB chairman J. A. Krug, included propeller, engine, and other component producers. The manufacturers were told that draft-exempt men must not be employed on these civilian orders. It is believed that most of the raw materials needed for airliners will be available.

C-54 Released For Tests.

AAF has released a Douglas C-54J, the AAF version of the DC-4, which is at present the four-engine leader on postwar airline order books, for test and airworthiness rating by CAA. The DC-4 series, initiated years before the war in a somewhat heavier design, has been a star in military air transport as the Army's C-54 and Navy's R5D, and much maintenance and operating experience has been built up in it. Craft is on postwar order by AA, UAL, PCA, EAL, NAL, NEA, WAL, and others.

The plane assigned for test has been used for that purpose by the AAF and is equipped with the necessary instruments. Several weeks of testing will be done by the Douglas Company at Santa Monica.

Many alterations will be made during trials, such as change of ailerons and flaps, and it is intended to cover as many C-54 variations as possible.

ATA Conference Gets Special Traffic Sections

Reorganization of ATA's Air Traffic Conference of America created three new specialized sections operating under an overall Assembly of Traffic Executives: (1) A passenger traffic section, (2) a cargo traffic section, and (3), a tariff publication bureau. These take place of the general conference which had previously handled all traffic matters.

Composed of the traffic heads of the 20 U. S. and 2 Canadian airlines, the overall Assembly is headed by Harold Crary, UAL vice-pres.-traffic. The Passenger Section, composed of passenger managers has as its chairman Willis G. Lipscomb of AA. Cargo Section is headed by Harry Stringer of All-American Aviation, and Tariff will be operated as part of the conference with J. B. Walker as manager.

AAF to Release Pilots For Airline Jobs

To meet increasing air crew needs of the airlines, the Army has agreed to release a number of pilots and co-pilots. Applicants for release are being interviewed by prospective airlines, and personnel selected are given letters to submit with their discharge applications. Needed are at least 1,000 pilots and co-pilots.

During the past 15 months nearly 10,000 more route-miles have been authorized by CAB, together with resumption of many suspended schedules and stops. The airlines now have over 375 planes, as compared with 209 on May 1, 1941.

In addition, the airlines have been asked to pick up about 50,000 soldiers, whom the AAF will fly from Europe to the East Coast in 800 military transport planes, and set them down at their home towns for furloughs, then fly many to West Coast for embarkation to the Pacific combat theaters.

NE Phila. Airport Re-Opening

As we go to press it is announced that Northeast Philadelphia airport was scheduled to re-open on July 1st after a shut-down period beginning Dec. 1943. Howard Shafer is airport's new manager, and it is stated that nine airlines have applied to use field, which is 14-mi. from the city's Broad St. station. When fully completed, the new terminal will have cost $12,000,000.

★ CROSS COUNTRY ★

Inter-American Safety Council gave awards to 21 airlines serving South and Central America for operations in 1944 without accidents or fatalities. Among winners was AA de Mexico with 27,588,000 revenue passenger mi. and Pan-Am-Grace with subsidiary companies which totaled 23,014,116 mi.

AEA announced CAB authority for new $100 round-trip excursion rate for N. Y.-Botwood Newfoundland flights. No priority is required. Sikorsky "Flying Ace" four-engined transatlantic flying boats are used.

PCA opened six flights-daily service from La Guardia Field with non-stop trips to Pittsburgh, three daily express flights to Chicago and three to Birmingham. Transcontinental connections are made at Chicago and for Southwest on southern div.

CAL began operating on new schedules that increased monthly air mileage from 288,600 to 666,480 mi. New flights provide three round trips daily between Denver-Kansas City and Denver-Albuquerque. Denver-San Antonio route was increased to two round trips daily. Other additions include one plane service from Colorado Springs and Pueblo to Kansas City, and added flight between El Paso and San Antonio. Airline received permission for new air route linking El Paso with Tulsa.

Delta Air Lines began regular air express shipments of fresh sea food from Savannah and Charleston to Atlanta after CAB approved reduced rates of six cents a lb. Special container with compartments for dry ice was designed by airline.

ATA reports: Air transport expansion plans call for 678 new scheduled airline stops in U. S., totaling 784,200 mi. of routes. At end of first quarter of '45, 344 applications were pending for new domestic service, plus 100 applications for foreign service, covering 634,028 route mi., and there were 87 applications for new Alaskan operations. In '44 airlines in U. S. are stated to have handled 1,775,838 express packages, a total of 34,270,864 lb.

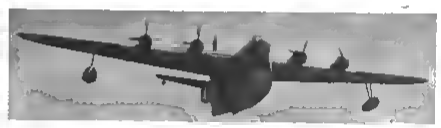
New, modern type airport terminal and administration building, to cost about $1,000,000, has been proposed in expansion of Lambert-St. Louis Municipal Airport. Plans call for airport enlargement to 1,400 acres.

Stated to be first recorded delivery of airborne asparagus, Ralph Myers, Calif. grower, sent 186 crates of asparagus, 20 crates of broccoli, and 6 crates of flowers, with total weight of 6,600 lb. via UAL to Carbone & Co., N. Y. C. Successive shipments have been made on Sundays when traffic is said to be light. Aspargus crate are specially designed to pyramid shape to custom fit contents. Weight saving is stated to be achieved by cutting two inches from asparagus butts, saving about 8-10 lb. per crate.

Braniff started service to Lubbock, Texas by making it a stop on airline's schedule between Denver and Texas points, and will operate from Dallas to Denver via Fort Worth, Lubbock, Amarillo, Pueblo and Colorado Springs. Airline is re-inaugurating service between Houston and Galveston, which had been suspended because of war conditions.

Formal leases for space at Idlewild Airport are expected to be signed soon, with at least a dozen of major U. S. airlines interested in new field. It is estimated that within a yr after V-J. airport would be handling 800 daily flights, and in full operation field would provide for 30,000 passengers daily and require a staff of 60,000 men and women. Completed airport is to have twelve 6,000-11,200 ft. runways, each 300 ft. wide, and capable of taking planes weighing 150 tons. Final stage of construction is expected to be finished in 1950.

NWA has opened a central transportation control office at Minneapolis with branch office at Billings, Mont., in order to expedite handling of passenger space. A plan is said to make it possible for company's ticket offices to be quickly informed as to seats available with minimum of communications between stations. The control office assigns



SHETLAND—BIGGEST BRITISH BOAT

New 65 ton Shetland flying boat is joint Short and Saunders Roe design, powered by four 2,500-hp. Bristol Centaurus 18-cyl. radial sleeve-valve engines. Seen here is military version, but construction has already started on commercial model, which is to accommodate 70 passengers and a crew of eleven. Freight compartments will have a capacity of 6,600 lb of cargo or mail. Craft has a 150 ft. span and is 110 ft. long. Cruising at 184 mph, and carrying 7,620 lb payload, it is stated range will be 4,650 mi. Fuel capacity is 6,112 gal. (British Combine photo)

space to each city where flights originate and clears requests for more space through this office.

Flight operations. UAL DC-5's possess 1,800,000 hr. aloft, with total air mileage at 180,488,804 mi. Figures cover period since 38 when planes were put into service by company. Planes being operated by company for Pacific ATC have reached utilization of eleven-and-a-half hours daily, flying about 42,500 mi. daily between San Francisco-Honolulu-Guam. . . . AA has flown 7,000th crossing of Atlantic for ATC. In a recent month airline flew more than 1,737,800 mi. . . . REA states that company's international air express shipments, coi incidental Canadian traffic, showed a 43.05% increase for first quarter of 46 over same period last year, with a total of 75,077 shipments handled. . . . NWA carried 78,867 revenue passengers in first quarter of 45, with revenue mi flown at 50,750,000. Increase was 168% in passengers carried over same period last year. . . . Consairway div has flown 6,808,008 ton-miles in 104,000 flight-hours in three years of Pacific operations. Average payloads have been 5,000 lb., and equipment utilization of bombers converted into transports has been 10 hr daily.

★ CALLING NAMES ★

(Continued from page 213)

west coast plants. **Robert C. Herlon** was promoted to mgr of personnel, **Wilford Genewa** was made new equipment mgr.

M. LeRoy Stoner has been appointed staff engineer, aerodept. of SAE, N. Y.

M. E. Sullivan became mgr of rates and traffic for Western Air Lines.

J. Story Smith, vice-pres.-engr of Jacobs Aircraft Engine Co., resigned his post.

John S. Wynne has been named legal counsel for Northeast Airlines in Washington, D. C.

Glenn L. Martin received an honorary degree of Doctor of Science from U. of Omaha.

Horace Balding has been appointed purchasing agent for Braniff Airways.

Donald W. Doherty became traffic representative in Minneapolis office of Mid Continent Airlines.

J. R. Yarrow resigned as airport turf engineer, airport service, CAA, to join Airways Engineering Consultants, Inc., Washington, D. C.

Alonzo Pettyes, vice-pres. and director of Farmer's State Bank, Brush, Colo., has been named a director of NWA.

J. Kirk Baldwin became airport consultant to Aviation Section of N. Y. Board of Trade.

Gerhard Maurie has been made chief engineer of Electrical Engineering & Mfg. Corp., makers of electric motors and actuators for aircraft.

Anthony Burke has been appointed to direct public relations office of Hughes Aircraft Co.

Chauncey J. Lake has joined Jack & Heintz' advertising dept.

K. R. Jemeson resigned his post as vice-pres. in charge of sales for Pacific Airmotive and has established firm of Jemeson & Co., with offices at 6710 Hollywood Blvd., Calif.

M. J. "Marty" Johnson became mgr of aircraft sales for Elastic Stop Nut Corp.

Murray T. Jackson has been named assl district traffic mgr with hq. in Miami and **Walter Pearce** became airline's station mgr of Sarasota, Bradenton, Fla.

Colonial Airlines elections: Sigmund Jones, pres.; **E. S. Ridley**, vice-pres.; **Branch T. Dykes**, vice-pres. in charge of operations; **Alfred M. Hudson**, vice-pres. in charge of traffic; **J. V. Flanagan**, treas.; **K. Hamilton**, secy., and **Carl L. Anthony**, asst. secy.

Harold D. Keantz became coordinator of planning for TWA. **J. F. Ehret** was made director of sales and service for airline's central region, and **Miss Jeanne Stanten** became traffic representative in Cincinnati.

Capt. Edward Nichols has been appointed mgr of new municipal airport at Merced, Calif.

Rear Admiral Harold B. Selleds was nominated by Pres. Truman to be chief of Navy's Bureau of Aero, succeeding **Rear Admiral DeWitt C. Ramsey.**

IAS elections: Rex B. Beisel, George W. Brady, William K. Buel, Sherman M. Fairchild and **Elmer A. Sperry, Jr.**, to council. **Walter Sarch, Laurence D. Bell, Allen G. Emil, C. L. Egtvedt, R. H. Fleet, Jack Frye, R. T. Goodwin, Robert E. Gross, R. M. Hazen, J. G. Hunsaker, Th. von Karmann, J. H. Kindelberger, P. W. Litchfield, F. W. Magin, Charles Mareus, Glenn L. Martin, R. C. Muir, Thomas A. Morgan, John K. Northrop, W. A. Patterson, E. T. Price, F. W. Reichelderfer, Fred H. Rohr, T. Claude Ryan, J. T. Trippe, Guy W. Vaughan, J. S. Vincent, Edward P. Warner**, and **Eugene E. Wilson** joined advisory board.

★ TAGGING THE BASES ★

Milwaukee's new 2,700 ft. flightstrip, next to Anthony Lange's seaplane base on waterfront, will be within 5 min. walk from business section. Plan was sponsored by Civic Committee on Aviation headed by Francis J. Traecker. Local operators **E. Merrill Anderson** and **Marie C. Buehler** worked on committee, says NATA *Dispatch*.

Thor Solberg, of Solberg Hunterton Airport at Readington, N. J., is now handling surplus disposal sales for RFC and has on hand Cessnas, Fairchilds, and Vultees.

Cleveland district operators have adopted cooperative newspaper advertising with good results. Ad in *Plain Dealer* listed Aircraft Service, Inc., Cleveland Flying Service, Dethloff Flying Service, Frank's Flying School, Tanner Flying Service, General Airmotive Corp., Horn's Flying School, Ideal Flying Service, Mother Airport, Aero-Ways, Inc., Ward Airport, Meltar Flying Service, Sky Haven Airport, Sky Tech, Inc., Sundorph Aeronautical Corp., and Budd Aero Airport. Western Finance Co. of same city has developed plan to finance pilot training and solo flight time.

Otto Airlines report future bookings on their Taterboro-Allenlo City route are heavier than were expected. Taterboro-Bairetown run is also busy.

Flying Farmers of Oklahoma will hold meeting at Okla. A & M. college on Aug. 2 and 3. Nearly 100 members are expected to attend, as well as airport managers from nearby states.

Agricultural Airplane Operators Assn has been formed at Yakima, Wash. R. A. Poulin, P. O. Box 1204, is Pres.

★INTERNATIONAL BRIEFS★

England

Gross weight of H.P. Hermes has been upped 5,000 lb., to enable plane to carry loads ranging from 4½ to 6 tons at 161 mph over ranges from 3,000 to 1,740 mi. With cruising speed of 240 mph and same loads, ranges are from 1,040 to 670 mi. Standard version will have accommodations for 94 passengers in a pressurized cabin. A freighter model is also under development.

English contender to Douglas DC-3 is Miles M-60 mounting two Merlins, and Miles M-60 with four DH Gipsyqueen engines. Prototypes of both are expected to fly shortly.

Society of British Aircraft Constructors has decided upon an export section, headquartering in London and having branch offices internationally to which trade ambassadors are to be sent to promote use of British aviation products. First on list for branches are Latin America, India, Far East, Middle East, and Dominions.

RAF is testing intact examples of late German Heinkel 177 twin-tandem-engine bomber and Me-262 jet fighter. It is noted that Junkers 004 jet units are reported to use ordinary Diesel oil instead of kerosene or more volatile fuels.

BOAC, in addition to its generous subsidy, is reported to have run up losses varying from 6½ million dollars in 1941 to nearly 8 million in 1944.

Four times weekly service between England and America has been started by BOAC with Flying 614's. These craft are later to be replaced by larger and faster Shetlands.

It is revealed that continuous bombing of Germany by RAF and AAF was enabled by British development of special fog-burning oil burners which were employed along military airport runways.

Among many new items displayed at recent air show in Paris was 60-cyl. 6-row liquid-cooled Mathis engine of 2,600 hp., prototype of a 7,850 cu.in. model reported to have developed 5,000 hp. during bench tests.

Gnome & Rhone is reported to have developed a 28-cyl. four-row engine of some 3,500 hp.

Netherlands

Internal air services are soon expected to be re-opened by KLM. In addition to connections with England, it is said company will continue operations to Lisbon and will also soon make trial flights to India preliminary to reestablishment of famed London-Batavia line.

Sweden

Courier air service between Sweden and U. S. with Douglas C-54 aircraft was recently inaugurated. Route runs via Iceland and Newfoundland.

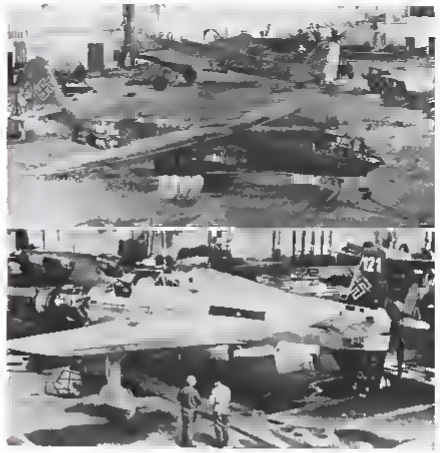
Notable cuts in fares were announced by ABA cost of passage from Stockholm to England being reduced to a new low of 650 Crowns (approximately $60). When service was initially opened, fare was double this amount. Similar reductions have also been made on line's domestic routes.

Czechoslovakia

Czech Government was recently assigned a number of surplus Douglas DC-3 type craft from European stockpile to enable both the CLS (privately owned) and CSA (government-owned) airlines to resume their services.

USSR

Aerial services linking Moscow, Warsaw and Berlin have been opened. Report did not mention type of aircraft used.



TOO LITTLE—TOO LATE

For Nazis to get any use out of 'em. That's the epilogue on these late-model German fighter bombers captured by U. S. Army units in last days of European war. In foreground of top photo is seen an Arado Ar 234 jet plane which saw action in only small numbers near war's end. Powered by two jet units, one beneath each wing, craft has retractable tricycle landing gear. Note (background) Junkers Ju-88 night-fighter-bombers with radar 'feelers' fitted just ahead of cockpit. (British Combine photo)

Dornier Do 335 (above) is tandem-engine craft with props at nose and tail. Plane seats at least two, has retractable tricycle landing gear, and its rudders extend both above and below fuselage. There has been no mention of this craft in action, so presumably it never got into mass-production. Top speed was above 400 mph at 25,000 ft. (Acme photo)

WORLOATA. . . . . By "VISTA"

In earlier issues we noted Australia's plans for complete nationalization of internal and international airlines, then told how Britain ventured the same path with its White Paper. However, the latter has since been relegated to the blueprint status. And now Australia's government likewise appears to have run into opposition, moves being underway to force a change in its viewpoint.

According to initial reports, Acting Premier Ford had blankly stated that the Australian airlines would be taken over by the government through a new agency. But then the subsequent official speech opening Parliament considered the plan in the proposal light, and attention to this marked difference is pertinent, states AVIATION'S Australian correspondent. It is noted that electors twice defeated the plan, that legal action by airline operators would seriously affect postwar expansion, that even the cabinet is not in agreement, and finally that a recent committee called for a company with 50-50 interest between government and public. There is popular approval for the latter plan in view of the success of similar organizations in Australia, contrasted with the failures of a number of purely government owned companies.

A recent issue of *Aeroplane* takes us to task for shortcomings of the British data in our 1945 Directory Issue, continuing with a general blast at American publicity methods and failure to give representative credit to British developments. We might say here that lack of space has a pertinent bearing on such coverage, together with the fact that the Directory is primarily for domestic consumption, thus calling for deserved accent on the national product. Specifically, however, we hasten to point out that neither precise nor comprehensive information has been available from either the British Air Ministry or English propaganda sources. Seldom it appears, are British manufacturers allowed to release official specifications. Accordingly, most information received here is either second or third hand, with all that implies. We can hardly present the proper details until the Britons contrive to cut their censor-gadda knot of Gordius—which, it is quite evident, was just what the *Aeroplane* was trying to do by taking a blast at us.

It appears now that British pressure to prevent American aircraft being sold to Commonwealth nations for commercial purposes, thus protecting British industry, has been extended to both Egypt and South Africa. The latter, it's reported, have been informed that their sterling balances would be blocked if they attempted to use them for purchase of American craft.

Australia

First North American designed P-51 Mustangs produced under license in Australia are expected to go into early action against Japs.

Sen. Nichols, of State of South Australia is planning to conduct his election campaign with a helicopter, making speeches from hovering craft. What make of rotor craft he has in mind has not been revealed. In any event, a well-rigged public address system is respectfully suggested for pitching his voice over operational noises of his up-and-down craft.

Japan

Nipponese industry has been exhorted to develop wooden aircraft also engines which can use substitute fuels now that supply of metals and oil has been restricted through heavy blows of B-29's.

Jacobs Aircraft Engine stock control has changed hands through the sale of majority holdings (58 percent) to Continental Engineering & Management Corp Continental firm (which has no connection with Continental Motors, Inc) also offered for a limited time to buy holdings of other stockholders at $6 a share Chairman J A Harris of Jacobs said the move was made to widen financial and manufacturing scope of his company

Bell Aircraft reported unfilled orders of $500,000,000 on Mar 31 Since then contracts for company's P-63 fighter have been cancelled, but larger B-29 bomber orders remain. Bell also reported 1944 net profits of $3,155,875 or $3 53 a share against 1943 profits of $2,462 - 414 or $7 77 a share. Sales were $317,473,879 against $232 134 - 628 in 1943 Current assets totaled $87,746,000 compared with current liabilities of $77,- 843 000

Bendix Helicopter, Inc., has sold 1,000,000 shares of capital stock at $2 a share Proceeds will be used to acquire additional facilities and personnel for continued research and development and for construction of flying production models of helicopters

Dividends. Recent dividend payments included Breeze Corp , 40¢ a share, Air Associates, 20¢, Braniff Airways, 15¢, Continental Motors, 20¢ Delta Air Lines, 80¢ annual dividend, and Glenn L Martin, $1.50. All above payments were the same as previously disbursed

Dividend Changes: United Aircraft Corp paid a $1 common dividend on June 15 compared with dividends of $1 50 a share in June and December of 1944. . . . Grumman paid a $1.50 dividend on May 24 compared with dividends of $1 in May and of 50¢ in November of 1944 . . . Ryan Aeronautical recently paid a special dividend of 15¢ a share which Pres. T Claude Ryan said was justified from 1944 profits

American Airlines reports March quarter net profits of $980,642 or 78¢ a share against net profits of $597,788 or 95¢ in the like 1944 quarter Operating revenues were $9,951 768 against the sum of $7,454 684 a year ago

Bellanca Aircraft Corp reports 1944 sales of $8 852,982 compared with $6,122,492 in previous year Net profits were $231,862 or $1.27 a share compared with net profits of $332,227 or $1 44 a share in 1943 A contingency reserve of $220 000 was set aside from 1944 earnings.

United Air Lines reports first quarter net income of $1,643,- 288, equal to $1 02 a common share, compared with net income of $1 110 083 or 68¢ a share in the like 1944 period. First quarter operating revenues were $8,382,593 against the total of $7,235,618 recorded a year ago.

Square D Co. reports first quarter net income of $446,378 or $1 01 a share compared with net income of $498,433 or $1 13 a share in the like 1944 period First quarter profits are figured after a reserve for renegotiation based on past experience, according to Pres F W Magin

National Airlines stockholders have approved an increase in capital stock from 500,000 shares to 1,000,000 shares Approval also was given to company's acquisition of Caribbean Atlantic Airlines, Inc , a line operating in Puerto Rico and Virgin Islands

Eastern Air Lines reports March quarter profits of $446,- 091 or 78¢ a share compared with net profits of $178,520 or 30¢ a share in like 1944 quarter Operating revenues were $5,872,925 in 1945 quarter, those for like 1944 period are not available

Transcontinental & Western Air reports March quarter net profits of $504,008 or 52¢ a share compared with a deficit of $102,403 in like 1944 period Operating revenues were $7,- 141 461 against $4,449,122 in Mar 1944 quarter

Pennsylvania-Central Airlines reports March quarter net income of $71,128 or 15¢ a share compared with a net loss of $52,518 in like 1944 quarter Operating revenues ware $1,- 991 687 against $928 688 in Mar. 1944 quarter

Northwest Airlines may move its headquarters from Minnesota unless personal property tax situation there is remedied according to company officials March quarter net profits of Northwest were $77,646 or 22¢ a share against net profits of $37,742 or 18¢ a share in same quarter of year 1944

Braniff Airways reports March quarter net income of $105,43E or 10¢ a share against net profit of $98 985 or 18¢ a share in same 1944 quarter. Operating revenues were $1,623-828 against $1,124 195 in like 1944 period

Western Air Lines reports March quarter net income of $117,607 or 29¢ a share compared with a net loss of $17 - 564 in corresponding 1944 period

National Aviation Corp. reports net assets per share of $19 80 on Mar 31 against net assets of $18 42 a share on the like 1944 date Net income for March quarter was $22,544 against $23,813 a year ago, while market value of investments held were $7,832,231 on Mar 31 against $6,59,818 a year ago

ADDING IT UP. . . . . By RAY HOADLEY

Profit Outlook. As had been expected, the recently announced aircraft cutbacks will reduce both 1944 gross business and net profits for the companies effected However the executives of some of those hardest hit so fer by cancellations privately assert that the cutbacks are not entirely unwelcome, since they will permit a more orderly reconversion than if all contracts were suddenly cancelled and will enable them to put more emphasis on preparation for postwar operations.

Financial Position. Certainly almost all companies are in a better position today to go through reconversion than they were a year ago Take the case of Consolidated Vultee which appeared to be definitely effected by the flock of cancellations occurring last month At the end of its 1944 fiscal year this company had $35 a share in net current resources, including rebates on excess profits tax and the value of unamortized emergency facilities Then, too, the company may be presumed to have accumulated substantial profits on the large deliveries made so far this year.

Competition. The automotive companies gradually are revealing their probable postwar stand with respect to aircraft manufacture. Studebaker executives have reaffirmed the position they have taken right along. With the cancellation of Studebaker's big contract to make Wright engines this company is turning toward resumption of automobile production and has no interest in the immediate postwar civilian aviation market On the other hand, Packard will keep the door slightly ajar through an experimental and research assignment on aircraft engines for the government.

Airline Earnings First quarter operations of the domestic airlines resulted in almost phenomenal gains in earnings despite the traditional poor weather in that three months period. Eastern Air Lines' profits gained 50% over a year ago, TWA reported net of $504,000 against a deficit in the like 1944 period, and Pennsylvania-Central turned a Mar 1944 loss of $77,000 into a profit of $169,000 in the first 1945 quarter And so it went through the industry

Airlines Outlook. But despite the excellent first quarter showing, airline executives maintain that accurate estimates of earnings for 1945 are impossible—at least for the larger lines—until the matter of airmail rates is disposed of The retroactive feature of the CAB proposal that mail rates be reduced from 60¢ a ton-mile to 32¢ might seriously effect the profits of those big lines which have been requested to show cause why the rate reductions should not be made Everyone is still wondering how much weight the CAB will give to the passenger fare cuts, averaging more than 10% which most lines already have put into effect

Mid-Continent Expansion. Pres J W Miller of Mid-Continent Airlines, speaking at the annual stockholders meeting gave a graphic example of the current progress his organization is making Revenue of Mid-Continent has been increasing more than 30% a year or, in other terms, has doubled nearly every 2½ yr since 1938 In 1944 the company's revenue jumped more then 70% from 1943, with 74,000 passengers carried or almost twice the number using the service in 1943

A. T. HAPKE, JR., has joined staff of American Petroleum Industries Committee of American Petroleum Institute, and will head newly created aviation section. Prior to this post, he had been market research manager for Republic Aviation. He is also a member of QB and Wings Club.

CAPT. EDMOND KELLY has returned to presidency of Aviation Equipment Sales Corp., Los Angeles, after three yr. in AAF. While in service he was stationed in production engineering div. at Wright Field. He volunteered for glider training and was later transferred to Materiel Command.

WELLWOOD E. BEALL has been elected to Boeing's board of directors. New vice-pres. in charge of engineering, he joined company in 1930. He was instructor in company's aero school, then successively became sales manager, chief engineer, and attained present post in '43.

REED M. CHAMBERS was elected pres. of Wings Club. He served in World War I with first American pursuit squadron to reach front. He became one of ranking U. S. aces and commanding officer of famed 94th pursuit squadron. He is also pres. of U. S. Aviation Underwriters, Inc.

JOHN C. HARROWER has been elected vice-pres. in charge of sales and engineering for Air Associates. His previous position was sales mgr. for Eclipse Aviation, and prior to that he had been production mgr. with Bendix Aviation. He has served as communications engineer for NAT.

JOHN J. HOSPERS (left) has been made sales mgr. for United Aircraft Corp. He formerly was field service mgr. for airplanes. Joining company in 1928, he served as field service mechanic, flight test observer and project man on experimental airplanes. In 1942 he joined United Aircraft Service Corp. **WILLIAM H. McCARTHY,** formerly company asst. field service mgr., is new field service mgr. With United Aircraft for 13 yr., he was with Sikorsky div. working on S-42, S-43 and XPBS-1 and was asst. chief inspector of final assembly and flight test for Vought-Sikorsky when he joined United Aircraft Service Corp. in '42.

ERIC JOHNSTON has been elected a director of UAL. Pres. of Chamber of Commerce since 1942, he is also pres. of Brown-Johnston, Columbia Electric Co., and Washington Brick & Lime Co., all of Spokane. He is a member of State Department's Economic Policy Committee. (UAL photo)

MAJ. EDWARD M. STURHAHN (left) has been appointed exec. asst. to CAA Administrator T. P. Wright. Maj. Sturhahn had been released from Aircraft Scheduling Unit of AAF to assume his new duties. In 1929 he was pres. and gen. mgr. of Ozark Flying Service, then became EAL's purchasing agent. **ROBERT W. CRAIG** has been named liaison officer between CAA and U. S. Weather Bureau, a newly created office for purpose of improving international weather forecasting and reporting. He is to be CAA's consultant on all weather problems and will assist in plans for extension of airways weather stations. (CAA photos)

C. HART MILLER has been appointed exec. vice-pres. and general mgr. of Republic Aviation. He is also vice-pres. and Farmingdale div. mgr. of company. Joining company in 1935 in an engineering capacity, he became test pilot, chief pilot, engineering asst. to pres., asst. to pres. In 1940 he was director of contracts.

VICTOR E. SEMRAU has been appointed secy.-treas. and controller of Pacific Airmotive Corp. His first position with aviation industry was with Aero Corp. of Calif. in 1930, followed by two yr. with Catalina Air Lines. Eleven yr. ago he joined Kinner Motors and became secy.-treas.-controller.

R. L. PROCTOR was appointed chief flight engineer for TWA's domestic routes and will be in charge of company's flight engineers assigned to Boeing Stratoliners as well as TWA's new flight engineer school. He had been asst. chief flight engineer on airline's intercontinental division flying Atlantic.

JULIA M. SCANLON (left) has been elected secretary of C-W Corp. and its subsidiaries. Her new position is considered one of most responsible held by any woman exec. in industry. Joining Wright Aero in 1928, she has been asst. secretary of C-W and Wright, also asst. secretary of L. G. S. Spring Clinch, and secretary-treas. of AWPC East Coast, Inc. **R. J. LINDQUIST,** vice-pres. controller, is new treas. In move to combine duties of these offices. He joined corp. and was made a vice-pres. in charge of finances in 1943, after having served as vice-pres. and director of Reynolds Metals Co. since 1941. He graduated from University of Illinois with B.S. degree and is a C.P.A.

By A. HARRY CROWELL *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U S Patent Office. Mr Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any patents listed are obtainable at a cost of 10c each, directly from U. S. Patent Office, Washington.

Stall Delaying and Indicating Mechanism embodies series of tabs located at various points on airfoil, with each tab connected in parallel in single electrical circuit, so that when any tab is actuated by stalling turbulence or reversal of flow, indicator is energized. Slot closures normally in closed position are moved to open position upon rising of tab, and act to automatically delay or quell stall.—2,373,883 filed Nov. 2 '43, pat. Apr. 17, '45, E. T. Allen and R. J. Minshall assignors to Boeing Aircraft Co.

Landing Gear, mechanically operated, intended to provide lightweight installation and positive action, includes retracting arm gear locking lever, and resilient means connected to said lever for urging it into interlocking engagement with gear retracting arm in either extended or retracted position. An unlocking beam is pivoted on gear retracting arm and is swingable into camming engagement with locking lever to move it out of interlocking engagement with gear retracting arm.—2,373,137, filed Apr. 8, 43 pat Apr 10, '45. C. J. Morgan.

Automatic Pilot to control rudder for azimuth steering incorporates auxiliary control element operative on pickoff from rate gyroscope and introduces follow-up means for pickoff, which is out of phase with primary impulse, by an amount roughly proportional to rate of precession of rate gyroscope. No oil throttle, special valves or pressure reducing bypass valve in the oil lines are required, amount of rudder throw being regulated by several air valves.—2,373,316, filed May 22, '40, pat. Apr 10, '45, P. W. Kenyon, assignor to Sperry Gyroscope Co.

Wing Flap Supporting and Operating Means is designed for air load acting on underside of flap to counteract action of flap power drive so that (at airspeeds at which deflected flaps lose their lift effectiveness, and upset airflow over fixed portion of wing, and also unduly increase the drag) this air load will overcome action of drive and positively prevent flap deflection or automatically effect retraction.—2,373,363, filed Dec. 13 '41 pat Apr 10, '45 A. H. Weathers assignor to Republic Aviation Corp.

Flap Transmission Mechanism is designed to move flap slot shutter to open position upon initial extending movement of flap, positively locking shutter in open position throughout further extension and finally returning shutter to slot-closing position as flap is raised.—2,373,842, filed Sept. 25, '41, pat Apr 10, '45, J. R. Clark, assignor to The Glenn L. Martin Co.

Pilot-Training Equipment for teaching rudder manipulation during ground operation includes cockpit of typical trainer fitted with stick, throttle lever, rudder pedals and units operated to cause turning, together with means whereby instructor may influence turning of cab to different directions so that student may practice rudder action necessary to overcome outside effects which resemble cross-winds or other conditions apt to be encountered.—2,373,836, filed Mar 1, '43 pat Apr 17, '45. T. C. Barber.

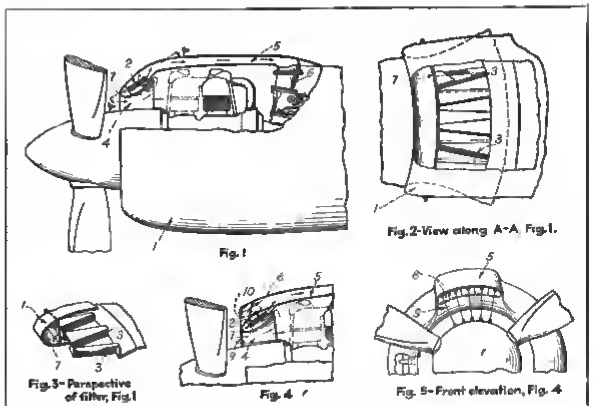
Auxiliary Bomb Rack Adapter, arranged chordwise under wing bottom and having capacity materially greater than usual bomb rack is designed for operative association with latter so that bombs carried by adapter may be discharged singly or in salvo with mode of operation being affected by mechanism of conventional rack.—2,373,904, filed Oct. 13, '40, pat Apr. 17, '45, C. H. Miller and C. H. A. Hartley, assignors to Republic Aviation Corp.

Anti-Icing System for wings is designed to prevent overheating by use of additional air room located on leading edges, and preferably in propeller slipstream, to cause considerable volume of cold air to mix with hot air passing through wing edge conduit and so reduce temperature of heated air to degree at which no damage to wing can result. Mixing of cold and heated air is continuous and automatic.—2,373,725, filed Mar 31, '44, pat Apr 17, '45, E. D. White.

Mixture Control for Aircraft Heaters, designed to regulate degree of richness, employs heat exchanger for cooling mixture withdrawn from carburetor and for condensing an appreciable portion of vaporized fuel contained in mixture. Included is separator to divide condensed fuel from mixture, together with means for adding liquid fuel to mixture at rate dependent on level of liquid in separator.—2,374,258 filed Mar. 7, '45, pat. Apr. 24, '45, H. J. De N. McCollum.

Jig for Large Aircraft, employed in assembling fuselage side panels to intermediate transverse floor member, is de-

(Continued on page 377)



Air Filter in form of annulus within cowl provides large area of screening material for passing air to conduit leading to carburetor intake, so that maximum volume may be filtered without appreciably reducing pressure. Manually operated gate provides for optional admission of air directly to conduit from outside of cowl without passing through filter. As seen in accompanying Figs. 1, 2, and 3, at forward end of cowl (1) and entirely housed within its periphery, is annular filter (2), having plurality of screens (3) angularly disposed to each other to increase total screening surface. Admission of air to filter is via cowl central opening (4), and after passing screens air enters conduit (5) leading to carburetor intake (6). Forward end of conduit (5) extends around periphery of cowl and radially outward of filter screens. Front wall (7) closes end of filter and countains air to pass through screening material. In embodiment of invention shown in Fig. 4 and 5, plurality of spring-hinged gates (8) provided just above upper portions of annular filter (2) and adjacent to front end of conduit (5) are manually operative from cockpit by cables (9). In normal open position, gate is held by spring hinge against outer wall of filter and air is admitted directly to intake conduit (6) from cowl without passing through the filter.—2,374,413, pat. Apr. 24, '45. F. Caldwell, assignor to United Aircraft.

Book Reviews

HIGH JOURNEY, by Carleton Putnam. Chas. Scribner's Sons, N. Y., C. 301 pages, maps, index. $2.75.
Most interesting story of author's student flying in Arizona back in Curtiss Robin days and how his aerial study of Western history led to the formation of Pacific Seaboard Air Lines, which was later developed—missing failure by a hair—into today's Chicago & Southern system. An extremely readable combination of reminiscence, philosophy, and the type of American business story that needs telling.

JUSTICE IN TRANSPORTATION, by Ame G. Wiprud. Ziff-Davis Pub. Co., Chicago. 197 pages. $2.50.
Considered here is monopoly control in transportation and its phases, and included is a section on future transportation. Foreword is by Thurman Arnold.

THE COMING AGE OF ROCKET POWER, by G. Edward Pendray. Harper & Brothers, N. Y. C. 244 pages, text, illustrations. $3.50.
Traces evolution of the rocket principle

(Continued on page 374)

SIDE SLIPS

NOW THAT A FEW of the industry's slipstick artists might be able to find a minute or so to raise their heads from formulas, leave us start a little internecine warfare just to keep things normal

A wag has just written in to define an aeronautical engineer as "a person who passes as an exacting expert on the basis of being able to turn out with prolific fortitude infinite strings of incomprehensible formulas calculated with micromatic precision from vague assumptions which are based on debatable figures taken from inconclusive experiments carried out with instruments of doubtful reliability and questionable mentality for the avowed purpose of annoying and confounding a hopelessly commercial group of fanatics referred to altogether too frequently as airplane designers"

Okay, engineers, the typewriter and dictionary are yours—but just keep it clean

• Pilots of two different fighter types were arguing the relative merits of their ships, as pilots *have* been known to do The argument ended abruptly when one 'em snorted, "Man, our ships are so fast that we just follow our own vapor trails back to base"

• "They laughed," said Rosie the Riveter, "first time I wore my slacks, but when I sat down they split."

• Guess the Boeing B-29's will have to be given a fighter designation too, judging from what the boys are doing with them Other day, for example, two of the last ones away from the target saw a third going down fairly close to the coast of Japan. Seeing the crew bail out they signalled for a rescue party, knowing it wouldn't be long arriving But just as they were starting on back to base, they saw five Jap fishing boats heading for the parachuting crew. As if that wasn't enough, six Jap fighter planes dove out of the clouds Calmly, one B-29 pilot radio'd the other, "You take the planes, I'll take the boats." So, like he was flying a single engine fighter, he hit the deck and the Japs—got four out of the five—while his compadre stayed upstairs, also making like a fighter pilot.

So help us, he got five out of the six planes, by which time the downed crew had been picked up

• Enroute to his native state of Texas the pilot—a swell ATC Captain—made no attempt to hide the fact he was glad to be going "home" even for a couple of days Consequently he took plenty of ribbing from his passengers, all of whom agreed he was as swell a gent as he was a pilot, partly because he really took the kidding which went on till they took off on the return trip He'd leveled off above the overcast and the 19 hangovers had settled back to feel sorry for themselves, when suddenly the cockpit door opened and the Captain shouted, "Gentlemen, may I have your attention please! Will you all stand up—in the aisle if possible, otherwise right in front of your seats The crisply added order "everybody up now" brought the 19 bewildered and slightly apprehensive headaches to their feet, whereupon the Captain announced seriously, "We will now observe two minutes of reverent silence as we leave the great state of Texas"

He got the door shut just in time

• Airplanes may get obsolete, but we're about convinced they never really die. A correspondent in Australia writes that the old trimotor Fokker, Southern Cross, made famous by the late Sir Charles Kingsford-Smith and Charles Ulmn, has been fully reconditioned by the Royal Australian Air Force." It's not going to war, though—it'll be used in a movie based on Sir Charles' life

'Maguire thinks he's going to be a millionaire with that expandable airpark to fit any community'

NEW PRODUCTS

KEEP POSTED ON *Products and Practices*

INFORMATION TIPS

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

ENGINEERING DATA

Universal Joints 1

Folder from Curtis Universal Joint Co., Springfield, Mass., describes joint devices and provides engineering data, including illustrations of templates for draftsmen and engineers.—AVIATION, July '45

Wood Products Development 2

Wood and its by-products and derivatives are discussed for benefit of engineers and executives in brochure from Timber Engineering Co., Washington, D. C. Title is *The Forest Industries Blaze New Trails* —AVIATION, July, '45

Stainless Steel Fasteners 3

Allmetal Screw Products Co., New York City, has issued new engineering catalog on non-corrosive fastening devices, from stock and to order.—AVIATION, July '45

Selenium Rectifiers 4

Manual for design engineers (Bulletin RDE-107) on selenium rectifiers is offered by Fansteel Metallurgical Corp., Chicago —AVIATION, July, '45

Glass Fabric and Insulation 5

Facts About Fiberglas for Design Engineers, booklet from Owens-Corning Fiberglas Corp., Toledo, describes uses of product, including insulation of aircraft compartments and ducts.—AVIATION, July '45

Actuators and Controls 6

Lear, Inc., Piqua, Ohio, has issued large loose-leaf manual, *Electro-Mechanical Aircraft Accessories*, describing each item in its various lines of actuators, controls, power units and accessories, together with specifications and engineering data.—AVIATION, July, '45

PRODUCTION

Rubber Adhesives 7

Booklet from B. F. Goodrich Co., Akron, lists general applications for rubber cements, includes designation of adhesives recommended, describes synthetic cements for synthetic rubber products and gives directions for application.—AVIATION, July '45

Coated Abrasives 8

Comparative information on "Durabond" coated abrasives is contained in circular from Behr-Manning Corp., Div. Norton Co., Troy, N. Y.—AVIATION, July, '45

High Solids Lacquers 9

Listing factors in development of new high solids lacquers, *Gig News on Lacquers*, leaflet from Hercules Powder Co., Wilmington, Del., considers advantages of product. A short history of lacquer is included.—AVIATION, July, '45.

Metal-Cleaning Agent 10

Troxide', new pickling agent for removing rust, scale, and tarnish from metals is covered in information from Waverly Petroleum Products Co., Philadelphia.—AVIATION, July, '45

Fastener Publication 11

Containing articles on stresses, physical properties and cold heading. Vol. 2 No. 1 of *Fasteners* technical periodical of American Bolt, Nut & Rivet Manufacturers, Cleveland, gives table on tension, shear and bearing values for common bolts and rivets.—AVIATION, July, '45

Degreasing Materials 12

Klem Kleaners materials for rust removal, degreasing and pickling are described in circular from Klem Chemical Works, Detroit.—AVIATION, July '45

Machining Manual 12

The Machining of Ampco Metal is title of Bulletin 66 from Ampco Metal, Milwaukee, which treats on various phases of machining, gives table of recommended lathe feeds and speeds and discusses tool design and inspection.—AVIATION, July, '45

Transparent Tape 14

Applied as gasketing material in construction of aircraft lighting and ignition harnesses and used for protection of wiring and cables, transparent "Fiberon" tape is described in literature from Irvington Varnish & Insulator Co., Irvington, N. J.—AVIATION, July '45.

Blind Rivets 15

Operating principles of company's blind rivets is explained in new manual from Huck Mfg. Co., Detroit.—AVIATION, July, '45

Alloying Agent 16

Cerium Metals Corp., N. Y. C., offers bibliographies on cerium as alloy agent with aluminum and magnesium.—AVIATION, July, '45

Nickel Plating Process 17

Company's bright nickel plating process, also equipment and technical service, are described in booklet from Udylite Corp., Detroit.—AVIATION, July, '45

Fastenings Catalog 18

New catalog and manual on self-tapping screws, socket screws, and other fasteners, has been issued by Parker-Kalon Corp., New York City.—AVIATION, July, '45

Rubber Engine Mountings 19

Containing simplified formula for calculating proper mounting for any given load. Bulletin GU-83 from Bushings, Inc., Berkley, Mich., offers dimension drawings of four typical rubber insulated engine mountings.—AVIATION, July, '45

Metal Balls 20

Types and specifications of metal balls made by Strem Steel Ball Co., Chicago, Ill., are contained in circular.—AVIATION, July '45.

Spray Booth Paint Removal 21

Booklet from Beothoost Div., Harris Soap Co., Buffalo, illustrates simplicity of process for removal of paint from walls and other parts of spray booths.—AVIATION July, '45

AVIATION READER'S SERVICE

JULY 1945

AVIATION, 330 W. 42nd St., New York City 18

Please send me additional information according to key numbers circled.

INFORMATION TIPS				1	2	3	4	5	6	7	8	9	10	11	12
12	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
21	32	33	24	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60	61	62	42	64	65	66
67	68	69	70	71	72	72	74	75	74	77	78						
NEW PRODUCTS:					79	80	81	82	83	84	85	86	87	88	89	90	91
92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
110	111	112	113	114	115	116	117	118	119	120	121						

NAME _____ TITLE _____

FIRM OR AFFILIATION _____

ADDRESS _____

Rotating Seal 22

Information is available on Spring-life Gyro Seal, new type rotating seal made by Technographics, Inc., Chicago.—AVIATION, July, '45.

MACHINERY & ACCESSORIES

Portable Storage Rooms 23

Information on portable rooms for storage of food, supplies, tools, and other equipment, is available from Drinkwater, Inc., Chicago.—AVIATION, July, '45.

Air Cylinders 24

Gerotor May Corp., Logansport, Ind., offers literature on double-acting non-rotating air cylinders designed without tie rods, for 150-lb. air and 350-lb. water service.—AVIATION, July, '45.

Elevating Ladder Tower 25

Bulletins from Universal Fittings & Scaffolding Co., Zelienople, Pa., describe new low-cost "Multi-Purpose" elevating-ladder tower designed for various airport work and plane servicing. Tower, which is elevated and extended by single hand-operated winch, has 360 deg. turning radius with variable inclination from 45 to 75 deg.—AVIATION, July, '45.

Brush-Backed Sanding Wheel 26

Circular from Exactone Tool & Die Co., Hollywood, Calif., describes "Sand-O-Flex", brush backed sanding wheel, used for sanding, deburring, finishing, and polishing irregular surfaces.—AVIATION, July, '45.

Adjustable Hole Cutter 27

Pamphlet from Bruno Tools, Beverly Hills, Calif., gives details of new type expansive bit for hand brace cutting of holes in wood.—AVIATION, July '45.

History of Abrasives 29

Booklet from Carborundum Co., Niagara Falls, N. Y., presents history and development of company and of carborundum products, including abrasives and refractories, etc.—AVIATION, July, '45.

Extrusion Presses 29

Schloemann Engineering Corp., Pittsburgh, Pa., offers circular on extrusion presses for production of tubular products, rods, bars, and all types of sections, strip, and wire rods.—AVIATION, July, '45.

Fuel Handling Equipment 30

Flotrol Systems, New York City, announces Bulletin FL-150-45, *Flotrol Systems, Inc., For Clean, Dry, Safe Fuels*; and Bulletin EX-150-45, *The Lewis EXCEL-SO Water Separator and Filter*.—AVIATION, July, '45.

Industrial X-Ray Units 31

Used for spotweld control, micro-radiography, and materials inspection, industrial X-ray units made by Picker X-Ray Corp., New York City, are described in bulletin.—AVIATION, July, '45.

Grouting Method 32

Non-shrink method of grouting, described as providing quick hardening, ductile, elliptrat and waterproof grouts, is topic of folder from Master Builders Co., Cleveland.—AVIATION, July, '45.

Coolant Separators 33

Magnetic automatic coolant chip separators for honing and grinding machines manufactured by Barnes Drill Co., Rockford, Ill., are detailed in circular.—AVIATION, July, '45.

Cutting Tools 34

Chicago-Latrobe Twist Drill Works, Chicago, offers circular titled *Cutting Tools for Efficient Operations* which lists and describes drills, reamers, and countersinks, and makes suggestions for their use.—AVIATION, July '45.

Carbide Machine Centers 35

Line of carbide tipped machine centers, made by Tungsten Carbide Tool Co., Detroit, is listed in company's Bulletin No. 127.—AVIATION, July, '45.

Chain Belts 26

Z Metal chain belts and their application is topic of Bulletin No. 450 from Chain Belt Co., Milwaukee.—AVIATION, July, '45.

Tool Bit Selection 27

Folder on proper selection and use of tool bits is available from Carpenter Steel Co., Reading, Pa.—AVIATION, July, '45.

Wire Rope and Chain Fittings 29

New catalog from Thomas Laughlin Co., Portland, Me., describes full line of drop forged wire rope and chain fittings, also contains charts and engineering data, such as dimensions of hoist hooks, comparative rope strength, and other information.—AVIATION, July, '45.

Dual-Ram Broaching Machine 29

Designed for surface broaching, improved line of dual-ram machines is treated in Bulletin YAD-44 from Colonial Broach Co., Detroit.—AVIATION, July, '45.

Truck Tapping Gear 40

Industrial truck standardized running gear, from which several types of trucks can be fashioned, is subject of Bulletin No. 1002MH, from Materials Handling Div., Market Forge Co., Everett, Mass.—AVIATION, July, '45.

Portable Lubrication Units 41

"Lubrikarts" lubrication dispensing units in portable form, are illustrated in circular from Alemite Div., Stewart-Warner, Chicago.—AVIATION, July, '45.

Carbide Tool Grinder 42

Improved carbide tool grinder is described in Bulletin No. 323 from Baldor Electric Co., St. Louis.—AVIATION, July, '45.

Use of Reciprocating Tools 43

The Art of Generating With a Reciprocating Tool, booklet from Fellows Gear Shaper Co., Springfield, Vt., is termed a basic treatise on art of generating, as performed by a reciprocating tool, with variations made possible by different combinations of rotative and transverse movements of work and cutting tools, in any direction required and to any angular relationship.—AVIATION, July, '45.

Portable Surfacer 44

Details of Model A-3 "Take-About" surfacer are contained in circular from Porter-Cable Machine Co., Syracuse, N. Y.—AVIATION, July '45.

Wire Belt Hooks 45

Bulletin from Bristol Co., Waterbury, Conn., describes wire belt hooks for flat belting and shows methods of applying.—AVIATION, July, '45.

Angle Molding Press 46

Watson-Stillman Co., Roselle, N. J., offers Bulletin No. 442-A concerning angle presses for molding complicated parts by transfer method. Molding of plastic products requiring split ends is also considered.—AVIATION, July, '45.

Materials Handling 47

Standard and engineered hydraulically operated materials handling equipment are shown in circular from Lyon-Raymond Corp., Greene, N. Y.—AVIATION, July, '45.

Die-Less Duplicating 45

O'Neil-Irwin Mfg. Co., Minneapolis, has issued new catalog on "Di-Acro" system of die less duplicating. Latest models of equipment are shown and improvements listed.—AVIATION, July, '45.

Thread-Milling Cutters 49

Various types of ground multiple thread-milling cutters are listed in bulletin from Continental Tool Works, Detroit.—AVIATION, July '45.

Decimal Equivalent Table 50

For pocket use, Manufacturers Screw Products, Chicago, offers handy table of decimal equivalents of twist drills.—AVIATION, July, '45.

Toggle Clamp 51

New catalog from Detroit Stamping Co., Detroit, contains description of new De-Sta-Co Model 616 push-pull lock clamp for heavy duty holding of work in jigs and fixtures.—AVIATION, July, '45.

Mercury Arc Converters 52

Standard mercury arc converters for induction heating operations in 500-2500-cycle frequency ranges are described in Bulletin B6373 from Allis-Chalmers Co., Milwaukee.—AVIATION, July, '45.

Cable and Wire Stripper 53

Lever type cable and wire stripper for use on synthetic, plastic, glass, and cambric insulation, is described in bulletin from Ideal Commutator Dresser Co., Sycamore, Ill.—AVIATION, July, '45.

Photo-Print Dryer 54

Reported to efficiently dry matte, semi-matte, or glossy prints, also blue- or black-and-white prints, B-3 table-type continuous photo print dryer is described in bulletin from Peck & Harvey, Chicago.—AVIATION, July, '45.

PLASTICS

Molded Plastics 55

The Story of Plastic Molding, brochure from Chicago Molded Products, Chicago, is manual descriptive of various forms of plastics. Given are data on characteristics, information on molds and their manufacture, and details of company's service.—AVIATION, July, '45.

Liquid Polystyrene 56

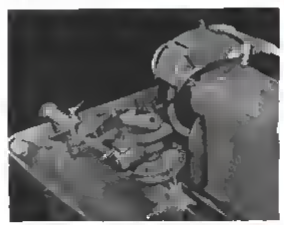
Recommended for doping, coating, impregnating, or sealing for radio frequency, ultra high frequency, very-high frequency, or general electronic applications, Polyweld, a pure polystyrene in solution, carrying product number 512, is announced in bulletin from American Phenolic Corp., Chicago.—AVIATION, July, '45.

Synthetic Rubber Sheet Stocks 57

Fabrics & Finishes Dept., E. I. Du Pont de Nemours Co., Wilmington, Del., has issued technical service manual on "Fairprene" synthetic rubber sheet stocks.—AVIATION, July, '45.

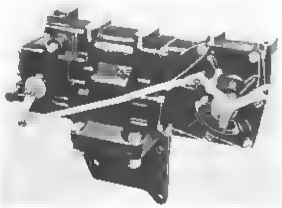
NEW PRODUCTS

Latest Machinery



grinds or laps carbide tools for lathes and screw machines, as well as tool bits with carbide tips inserted in milling cutters. When tool is clamped in adjustable holder and set by built-in protractors for cutting edge and clearance angles, uniform reciprocating action of tool across diamond wheel assures straight face and keen edge, states maker. Holder can be slid from rough grinding wheel to finish grinding wheel without removal. Fine adjustment controls feed of tool, and tool holder rest bar prevents tool from dipping into wheel. Spindle speed of 3,400 rpm. is attained through V-belt from ¾-hp. motor. Tool holder is mounted on shaft which pivots and slides axially in bronze bearings. Compression spring mounted in cup on either end of shaft assures constant thrust against micrometer nut. Thrust ball bearings on either end of shaft insure free pivoting.—AVIATION, July, '45

Aircraft Parts & Field Units



dince pilot fatigue automatic boost controls developed by Eclipse-Pioneer Div., Bendix Aviation Co., Teterboro, N. J., are for application to various single stage single-speed and single-stage two-speed supercharged engines. Maker states that due to military restrictions, design and engineering data are available only to manufacturers approved by Government.—AVIATION, July, '45

Ignition Transformers 83

For use in igniting fuel in gasoline fired aircraft cabin heaters and for de-icers, three new 115v, 400 cyc. ignition transformers have been developed by General Electric Co., Schenectady, N. Y. Units are shielded to minimize radio interference over all wave bands from 110 kilocycles to 200 megacycles. Two units with output capacity of 8,000 v. each, are of single-secondary type, while third has double secondary rated 6,000//6,000v for heaters with dual ignition or for two separate heaters. Designed to withstand vigorous service, maker states they will operate over ambient temperature range from —70 to +140 F. at altitudes to 40,000 ft.—AVIATION, July, '45.

Black Light Lamps 84

Aircraft instrument illumination with black light through use of special lamps

is announced by Sylvania Electric Products, Salem, Mass. Lamps are for operation on 120v a.c. and 24-28v d.c. Near ultra violet BP 12 rated at 4w, is designed for use with a visible light filter where lightweight, compact lamp is required. It is equipped with polarized bayonet base and may be operated in any position. Red-purple series tubular lamps require no visible light filter and operate with standard fluorescent lamp accessories on 220v a.c. They are supplied with miniature bi-pin bases in five sizes ranging from 6 in. T5 rated at 4w to 96 in. T8, rated at 30w.—AVIATION, July, 45.

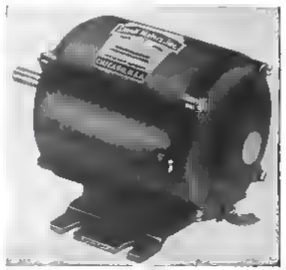
Cowl Door Track Roller..... 85

Reported to eliminate binding and jamming, new universal track roller for cowl and flap doors, and other sliding

members, has been developed by General Engineering & Mfg. Corp., Newark, N. J. Rollers, of ¼ in. dia., are available in shaft lengths of ⅝ and 13/16 in., or to specifications.—AVIATION, July, '45

Fractional HP. Motor 86

New small a.c.-d.c. aircraft appliance motor, made by Small Motors, Chicago is designed to provide maximum power per



ounce of weight and per inch of space. Designated as SM-4 model, motor develops 1/50 to 1/10 hp. It is of 3 5/16 in. dia., 4 13/16 in. long, and 3½ in. high with rigid base. Weight is 3 to 4 lb. Speeds are from 2,000 to 10,000 rpm with

precision ball bearings and 10,000 to 20,000 rpm with oil less sleeve bearings Speed reduction features are built in to order Motor is wound for any voltage from 6 to 250—**AVIATION, July, 45.**

Electric Starter and Tester 87

For use in engine starting and accessory testing without batteries electro starter made by **Knrz & Roel Co.**, Appleton, Wis. is three wheeled rubber-tired unit fitted with brakes and weighing about 1,200 lb Motor with input of 400v is 3-phase 60 cyc a.c. Generator output capacity is 24 28v 400 800 amp, d.c. Control panel has push button starter, rheostat for manual operation, and switch for automatic voltage regulator operation. Switch panel has two disconnect switches providing 2 separate circuits so that two aircraft can be serviced at once—**AVIATION, July, '45.**

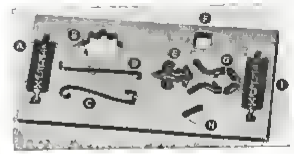
Fixture has vertical post and provision for grinding round shank drills in four point angles 49, 59, 69, and 8° deg Devised to hold drills from 3/32 to 1 1/16 in. dia. grinder will sharpen short medium and long twist drills from 1½ in. through 11 in. lengths—**AVIATION, July, '45**

Aluminum Cleaner 90

Reported to remove stamping inks from aluminum and to help provide superior surface for welding Improved form of KDL No 1 material for hot tank cleaning, is offered by **Kelite Products**, Los Angeles—**AVIATION July, '45**

Spark Drilling of Shaped Holes ... 91

Elox Corp., Detroit describes "disintegrator drilling," or drilling of shaped holes electrically, as same process as electrical disintegration of broken tools. Either solid or hollow electrode may be used In illustration figures (F) and (H) were made with hollow electrode Slots in figures (C) and (D) were formed by strip stock electrode Figures (B) and (E) were drilled by custom-made solid electrode—**AVIATION, July, '45**



Hermetically Sealed Instruments ... 92

Hickok Electrical Instrument Co., Cleveland, announces 2½, 3½, and 4-in round style electrical instruments hermetically sealed and with internal pivot construc-

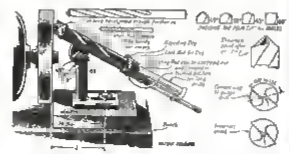
ShopEquipment & Materials

New Rotameter Tube 88

Three straight glass ribs running up inside tube to guide rotameter float throughout its travel distinguishes new rotameter tube made of boro-silicate glass Manufacturer, Fisher & Porter Co., Hatboro, Pa., states that centering float improves accuracy, prevents tube breakage and permits float shapes that are not stable without guides New tube can be adapted to existing type rotameters.—**AVIATION, July, '45**

Four-Angle Drill Grinder 89

Designed to simplify difficult grinding operations, four-angle drill grinding attachment with improvements is announced by **A. D. McBurney, Los Angeles.**



tion. These 4-in. round sets for use in radio service equipment where several scale arcs are required, they have body dia. of 3½ in. and flange dia. of 4½ in., taking mounting hole radius of 1-15/16. Among instruments are voltmeters, ammeters, milliammeters, and microammeters, a.c. and d.c. All sizes are housed in metal cases, hermetically sealed with dry air at sea level pressure, or with inert gas. Terminals are glass soldered in type, glass being direct-bonded to metal. Use of 'Alnico' magnets permits use on steel panels. Maker states instruments will operate properly at 85 deg. C.—AVIATION, July, '45

Roughness Standards 93

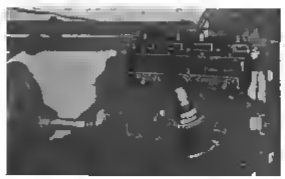
Containing a 6-page educational text bound to a gage consisting of 20 replicas of machined surfaces (prepared by turning, grinding, milling, honing, lapping, and polishing) which vary in roughness from 500 to 5 micro inches (photo, right), 'Surf-Chek' Roughness Standards provides method of designation from engineer's instructions and is stated to enable rapid and efficient roughness comparisons without need of instruments. Maker is Surface Checking Gage Co., Hollywood, Calif.—AVIATION, July, '45

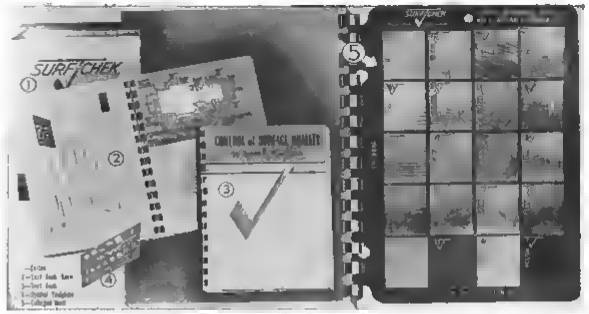
Plug Gage 94

New Duo gage is bore checking gage of fixed ball type. Sizes from .240 in. to 1.510 in. dia. have "Go" and "No Go" members attached to opposite ends of lightweight metal handle, while sizes from 1.510 in. to 3.010 in. dia. are single end gages, individually mounted on palm-fitting plastic handles. 'Go' members are marked with green enamel and "No Go" members with red, under transparent plastic ring. Handles of double-end gages also have dots of color. Gage head is thin disk which is section of sphere. Gaging surface makes contact with bore walls only at instant and point of bore gaging. Two chamfered sections diametrically opposed on each member, enable operator to enter gage into bores easily and almost to bottom of blind bore. Chamfered edge also tends to wipe away foreign material from gaging area. As gage can enter bores smaller than its dia., it checks out-of-roundness and taper. When checking bore for lower limit, "Go" member is entered with handle held lightly and tilted slightly above axis of bore, then lowered gently. Undersize spot arrests handle, and oversize spot allows handle to drop freely. Upper limit checking is done in same manner, using 'No Go' member. Maker is Standard Gage Co., Poughkeepsie, N. Y. Photo shows gaging of highly finished bore of bronze airplane bushing.—AVIATION, July, '45.

Compressor Head 95

Designed for use on Model A or B Ford motor block, Mogul model 185 com-





pressor head is offered by **Metallizing Co. of America**, Chicago. It is designed to enable recovery of scrap blocks. Head is designed to deliver volume of 138 cfm with actual delivery of 100 cfm at 100 lb pressure. Unit includes valve and water chambers, air intake manifold, air strainer, unloader, pilot valve and necessary parts for assembly.—**AVIATION, July, '45.**

Centrifugal Pumps 96

Higher volume delivery per hp and ease of maintenance are reported features of new line of Superflo centrifugal pumps made by **Gray Mills Co.**, Chicago. Heavy duty motors are mounted integrally, ranging in sizes of 1/25 hp, ¼ and ½ hp, with volumes of 0 to 75 gph. Thirteen basic models are available, with various voltage characteristics. There are types for horizontal external mounting and for vertical external mounting. Other pumps with floating impellers are made for submerging in coolant system reservoir. Bearings and pump seals are sealed in, require no lubrication.—**AVIATION, July, '45**

Unit Cleans Engines and Parts 97

New degreasing tank for aircraft engines and parts may be wheeled to plane for insertion of engine. Made by **Process Equipment Engineers**, Redding, Mich., "Dee Greaser" is stated to be entirely new in design. It uses air agitation for cleaning and can be equipped with air driven brush gun. Small trays may be inserted for small parts. Tank employs distillate plus chemical cleaner, both harmless. Residue is water soluble, hence washes off easily after soaking. Unit is offered in several standard sizes. Other models may be built to specifications.—**AVIATION, July, '45**

Stitch Finder 98

New attachment on aircraft stitchers locates position of stitch visually by means of light reflected in form of cross and in one or two adjustable spacing lines if desired. Reflection appears on wheel of transparent plastic which is really a transparent mirror so adjusted that cross appears to be on work exactly where top of stitch will be. After first stitch, work is moved either to right or left so stitch is covered by line of light. Maker, **Herrie Seybold-Patter**, Dayton, Ohio, states device eliminates use of gages and fixtures. —**AVIATION, July, '45**

Fire-Fighting Nozzle 99

New dual-stream nozzle announced by **Dugas Div., Ansul Chemical Co.**, Marinette, Wis., is described as permitting operator of company's wheeled model extinguishers to apply dry chemical either as long range straight stream or as short range fan stream. Overhead fires can be extinguished successfully, reports maker. —**AVIATION, July, '45**

Spotwelding Tweezers 100

Developed to weld radio tube wires, these spotwelding tweezers made by **New Jersey Jewelers' Supply**, Newark, N. J. have found applications on many other small, precise units, such as instruments for aircraft. Tweezers are of copper forged and insulated, having plastic covered flexible, copper leads terminating in pair of lugs which connect in place of regular welding electrodes. Copper jaws hold like ordinary tweezers, are brought in contact with parts to be welded, then foot switch is pressed, current applied and weld is made. Tweezers operate from ½ to 1 kva on 10 amp current and they are used with timer.—**AVIATION, July, '45.**

Parallel-Resistance Calculator 101

Slide-rule calculator developed by **Allied Radio Corp.**, Chicago provides means of determining reciprocal of sum of two reciprocals as expressed by formula $\frac{1}{x} = \frac{1}{a} + \frac{1}{b}$. Single setting automatically aligns all pairs of a and b values which will satisfy equation for any given value of x. Calculator indicates in one setting the numerous pairs of resistances which may be connected in parallel or capacitances in series to provide any required resistance or capacitance value. Range is 1 ohm to 10 megohms, 10 mmfd. to 10 mfd. Capacitance and resistance figures on rule can also serve to represent inductance, impedance, reactance, or other units.—**AVIATION, July, '45**

Tap Saver 102

Reported to practically eliminate tap breakage where this factor has been very high, safety insert for tapping heads, made by **Tapping Tool Co.**, Towson, Md., is grooved piece of soft alloy metal which replaces steel jaws formerly used to hold tap. Insert made in one piece, is used only for one size tap in any kind of head. When tap jams, soft metal of insert allows tap to cut away, permitting tap to remain stationery while head continues rotating. By rotating insert to new position each time tap jams same insert may be used many times.—**AVIATION, July, '45**

Laboratory Oven 102

Designed for precision experimental work in drying, baking, evaporating, polymerizing, aging, and heat treating, compact and self contained oven is offered by **Industrial Oven Engineering Co.**, Cleveland. Sizes of working space range from 8x8x8 ft. to 6x6x6 ft., in increments of 1 ft., with special sizes to specifications. Temperatures range up to 800 deg. F., with guaranteed differential of ± 2 deg. Any type of fuel may be used.—**AVIATION, July, '45**

New Lock Nut 104

Adel Precision Products, Burbank, Calif., announces "Steleck" new self locking nut for sheet metal fastening described as one-piece resilient-spring steel stamping which grips screw threads all around with equideg engagement.—**AVIATION, July, '45**

New Air Driven Motor 105

Described as developing more than twice piston thrust force of Model BX-1 on given air line pressure, Model CM10 air motor made by **Bellows Co.**, Akron, Ohio, has been designed on same basic principle of lateral valve operating, and speed controls.—**AVIATION, July, '45**

Plastic Gage Collets 106

Metal collets are replaced by colored, dielectric plastic collets in cylindrical ring gages made by **United Precision Products Co.**, Chicago. Green color identifies Go plug and red the "No Go." Both plugs are in same handle. Maker reports plastic collet grips plug with more secure hold, stating it cannot be twisted out with vise or wrench, but is easily removed by use of drift. Double ended gage is reversible.—**AVIATION, July, '45**

Carbide Insert Blast Nozzle 107

American Foundry Equipment Co., Mishawaka, Ind., announces full line of blast nozzles for high service life. They are equipped with Norbide boron-carbide inserts, jacketed in abrasion-resisting alloy steel.—**AVIATION, July, '45**

Air Filter Cleaner 108

Reported to eliminate use of distillate and other materials which leave offensive odors, new process for chemical cleaning of air filters in aircraft has been developed by **Turco Products, Los Angeles**. Filter is immersed for 5 min. in "Aktiv" solution, hosed off with cold water, dried with compressed air, then dipped into special oil.—**AVIATION, July, '45**

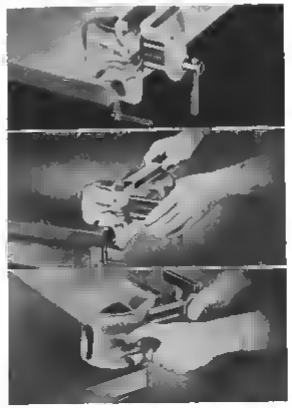
Deburring Process 109

Parts of brass, magnesium, aluminum, steel, iron castings, and stampings also precision-machined parts are stated to be uniformly deburred and smoothly finished by process developed by **De Burr Barrel**

Co., Los Angeles. "De Burrettes," used in tumbling barrels are made of soft synthetic rubber impregnated with aluminum oxide abrasive. Maker states that since each particle of abrasive is rubber mounted, cutting action is cushioned, soft metals are not marred, and a constant, even pressure provides fast cutting action on hardened steel.—AVIATION, July, '45

Quick-Action Vise 110

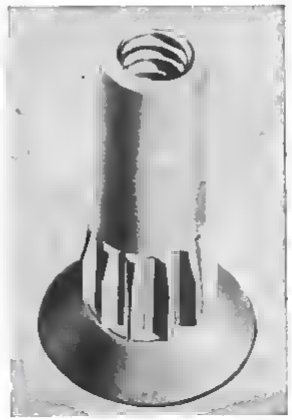
Action is stated to be speeded with new Quikset alloy-steel machinist's vise made by Grand Specialties Co., Chicago. Trigger release pawl enables running free



jaw in and out without use of screw. Screw is held under spring tension, and maker states vise opens instantly to full 3-in. gap at a touch after single turn of handle.—AVIATION, July, '45

New Type Fastener 111

Addition to line of "Rivnuts" manufactured by B. F. Goodrich Co., Akron is splined type for use in wood, plastics, leather, hard rubber, or other materials. Splines beneath countersunk head supply resistance to torque, while bulge or upset which forms below end of splines furnishes tension resistance, locking nut in two ways. Internal threads left intact within shank take attachment screw for installation of accessories. Standard tools are used. Three sizes of nut are available —6/32, 8/32, and 10/32 in aluminum or brass.—AVIATION, JULY, '45.



ANNOUNCEMENTS—

of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

In writing, emphasis upon specific aviation applications of newly-marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—
New Products Editor, AVIATION
330 W. 42d St., New York City 18

Over-Capacity Step Collets 112

Zeger Tool Co., Cleveland, announces over-capacity step collets for both 1- and 2-in. fixtures. No. 801 2-in. collets are made in 3, 4, and 5 in sizes. No. 801 collets (8 in.) can be used wherever type "C" collet is used. Heads are 1 in. thick, are made of M-tempered tool steel, are finished ground complete, and are left in soft condition. Heat treating instructions are included.—AVIATION, July, '45

Container Grease Gun 113

An original grease container can be converted into 25 lb high pressure grease gun through attachment of Model 1238 "Handi-Luber", states manufacturer. Device is compact high pressure pump equipped with hose assembly and hydraulic coupler. Manually operated and developing 8,000 psi., it dispenses light cup grease or viscous types. Maker is Lincoln Engineering Co., St. Louis.—AVIATION, July, '45

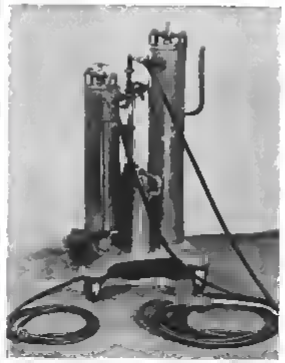
Taper Boring Attachment 114

Designed for easy mounting on any hand screw machine or turret lathe, and on some Bullard and chucking machines,

new turret attachment for boring tapers and profile holes is reported to produce perfect tapered or straight holes without change in setup except moving back top slide. Only care reported required is to maintain same dial setting specified to remain constant regardless of length of stock. Maker is Artisan Tool & Cutter Co., Ferndale, Mich.—AVIATION, July, '45

Aero Engine Storage Preparer 115

Designed to prepare aircraft engines for storage by spraying entire inside with oil, Model PA 747 aircraft engine preparer is announced by Airplane Mfg. & Supply



Div., Pacific Airmotive Corp., North Hollywood, Calif. Oil is heated by an immersion heater, and air is filtered through silica gel contained in separate pressure tank. Working pressure of 30 lb. of air is required. Unit is portable.—AVIATION, July, '45.

Electrical Appliances

Voltmeter-Ammeter 116

Combined in case, a.c. voltmeter and a.c. ammeter provide readings of both current and voltage simultaneously. Instrument is Model 621 voltammeter made by Associated Research, Chicago. Ammeter measures from 0-2 to 600 amp. in 6 current ranges: 0-2, 0-5, 0-10, 0-25, 0-50, 0-100, 0-250, and 0-500. Voltmeter measures from 0-150 to 0-750 v. in three ranges: 0-150, 0-300, 0-600, and it can be used in d.c. at these ranges. An inserted primary current transformer with 6 ft. secondary leads facilitates measurement of current on 0-100, 0-250, and 0-500 amp. scales without subjecting meter to stray magnetic fields. Size of case is 13½ x 9½ x 10 in. Weight is 25 lb., packed.—AVIATION, July, '45.

New A.C. Arc Welders 117

Two new a.c. arc welding machines, Standard 701 and Standard 251, made by Ergonyle Mfg. Co., Philadelphia, are designed to replace company's plug in models. Maker emphasizes ease with which whirlwind air cooling assembly and cyclone automatic arcing assembly can convert either of new machines to specific welding needs, stating that by addition of these units, four different machines are made. Standard machines plus fan and conversion accessories provide a.c. welding machines for continuous welding or machines that strike a quick arc with practically any type of rod.—AVIATION, July, '45.

Non-Resonant Capacitors 118

Described as advantageous in filtering or bypassing over wide frequency bands, Hypass capacitors made by Sprague Electric Co., North Adams, Mass., are stated to show no resonance at frequencies as high as 50 megacycles and in many instances up to 300 megacycles. Capacitors are installed in connecting in circuit in same manner as low pass filter would be connected. Two terminals are connected in series with circuit with container grounded. They may be used to eliminate hash in mains circuits.—AVIATION, July '45.

Electromagnetic Engraver 119

Aircraft industry uses for new electromagnetic free-hand or pantographic engraving tool are: Marking parts for selective assembly or position in assembly; placing timing marks on flywheels; going lay out work on sheet metal or plastics; cutting of irregular shapes from thin sheet aluminum, steel or brass shim stock and from thin metal paper or composition gasket material. Visited is Electro Mag Mfg. Co., Rockford, Ill.—AVIATION, July, '45.

Alloy Cast Connectors 120

New alloy called 113L for cast current carrying parts of electrical connectors is described by maker, Burndy Engineering Co., New York City, as the alloy 113 with lithium added, which strengthens parts materially since casting is denser and finer-grained.—AVIATION, July, '45.

Magnet Driver Units 121

In permanent magnet driver units manufactured by University Laboratories, New York City, features reported as exclusive are: Molded diaphragm flexing surfaces plated to outlast metal; heatproof voice coil suspensions; and hermetically sealed dust covers spun over entire unit structure, giving waterproof protection. Also described as important

is rim centering of voice coil assembly in magnetic gap to give permanent position ing of voice coil assembly. Model PAH (illustrated) is rated 20 w., impedance is 10 ohms, and frequency is 100 to 6,000 cys. Dia. is 6¾ in., height 8 in., and weight 8 lb. Model SAH is rated 2 w., impedance is 15 ohms. Frequency is 100 to 6,000 cyc. Dia. is 4½ in., height 5 in., and weight 3 lb.—AVIATION, July, '45.

"Sizing" Overhaul Shops

(*Continued from page 181*)

operations required. Perpetual shifting of workers would bring about slow sections in the line and inefficiency. With continuous flow overhaul, time and production are of the essence.

As mentioned previously, the sample overhaul depot under discussion employs about 1,200 people, 38 percent of whom are women. Inspectors number 130. Not included in the original figure are the several other groups, such as production control, material coordination, and the methods department. Some sections may work two or three shifts, although such schedul

ing is usually confined to the machine shop and engine test sections. A conception of the contrast between this and the small airline shops may be gained by comparing the latter's 100–150 overhauls per year with the figure of about 50 engines torn down per shift in the continuous-flow shop.

Organization of the large shop is quite involved, as indicated in the diagram of Fig. 2.

In general, this kind of shop functions in a manner closely approaching the production systems found in manufacturing plants. Parts move along conveyors from station to station, without regard to individual engine numbers. Workers are not expected to set up machines or jobs for themselves. Specific instruction sheets furnish them with every detail of their particular task. Tools are checked out and mounted on backboards with identifying markings. Certain exceptions to this tool system are applicable to supervisory personnel and machinists.

Engine storage and preservation is of paramount importance to large shops, and paradoxically enough promises to be quite vital to the small shops expected to spring up after the war. Any overhaul operator who receives engines from far distant shipping points and who must either return or store them will have the corrosion problem to beat.

Continuous-flow overhaul is a distinct, integrated industrial process with little room for individual craftsmanship. It produces a work volume unobtainable by other methods, but it makes it extremely difficult to fix responsibility, and it does not turn out the painstaking quality of work expected from the smaller shop.

Aircraft Dividends

(*Continued from page* 112)

Such stocks as Bell Aircraft, Curtiss-Wright A and common stocks, Glenn L. Martin Co., and North American Aviation have been selling to yield better than 10 percent on the basis of their present dividends, while Beech, Consolidated Vultee, and Lockheed have sold to give almost as high a yield. Even Boeing, which appears among the best situated for big volume operations for the duration of the Pacific war, currently sells to yield almost 10 percent.

The aircraft stocks generally are selling for less than their net working capital and also less than five times their 1944 net income after taxes. Ten times earning power is often cited as a yardstick for stock market prices.

Why is it that the aircraft stocks

give the largest yield of any single group on the New York Stock Exchange? It is because Wall Street has regarded the wartime earnings and dividends of the plane makers as only transitory ever since the war began. Brokers feel that wartime earnings will merely represent "paper profits" unless the companies come through the war in good financial condition.

Thus, as far as the aircraft companies are concerned, Wall Street is interested primarily in their financial positions, how well they weather termination and reconversion problems, and their postwar prospects.

It seems to be generally assumed that the long-term future of the industry is fairly bright in that annual volume eventually will be much larger than it was before the war. Right now the problem is one of cutting back to size.

It is conceded that much has been done both by government and the industry during the past year to smooth out reconversion problems. Surplus disposal policy remains about the biggest hurdle to be straightened out. So there is much less talk today of the coming struggle for the industry's survival than one heard two years ago. But the industry didn't pull any punches then in telling Congress and the public what would happen if reconversion and termination plans were not set up. Congress and the war agencies were impressed and acted. Wall Street and investors generally were also impressed and are still thinking of those dire warnings.

So the fact that most of the industry has salted away substantial reserves for the inevitable rainy day hasn't made much of an impression yet on Wall Street. Unnoticed is the fact that the industry has had to make surprisingly little use of the new termination loan devices set up by Congress.

But if the industry had not greatly improved its financial condition in the last two years, the aircraft shares would be selling lower than they are today. And action such as United has taken to fortify further its financial position cannot help but have a favorable effect on the stockholder's position.

Not until Congress indicates its postwar aircraft procurement policy can the future prospects of the average company be evaluated with any degree of accuracy. In the meantime aircraft stocks must be rated on their balance sheet condition as much as on any other factor.

Up to now the aircraft and the air line companies have followed pretty much the same path in capital financing. In both cases new capital has been obtained largely through the sale

of stock. From here on their paths will diverge quite sharply. The tendency will grow among the airlines to finance working capital needs through medium-term loans.

But the manufacturing concerns, aside from the ample credit available to finance war contract terminations, will continue to do the larger share of future public financing through the sale of common or preferred stock. Fortunately war production hasn't had to be financed through big stock issues, and preferred stocks are still the exception rather than the rule in the industry.

The availability of equity capital for aircraft manufacturing will depend upon the prospects for profitable operation after the industry has shrunk back to its normal size and upon the general availability of new capital for equity financing. The effect of taxation on the attractiveness of risk-taking is one of the factors which will determine the readiness with which new equity capital can be obtained in any industry. Congress appears in a mood to be helpful in that respect.

Certainly there have been times in the past when the aircraft industry was in a worse plight than it is today, despite its manifold problems. The period of reconversion has already started for some companies. There seems to be every indication that the storm will be weathered.

Tunnel for Sonic Speeds

(*Continued from page 157*)

½ in. in between the shafts and a change of 2½ in. in the gap between them, to allow for expansion and strain in the tunnel structure.

The drive shaft is enclosed in a 22 ft. long steel tube, one end of which is welded to the tunnel shell and the other to the upstream nose of a 12-ft.-dia. 50-ft.-long nacelle housing the fan shafts, bearing mounts, hubs, and sockets of the fans.

Airflow in the fan section is through the annular space between the nacelle and the tunnel shell, directed by the twelve upstream vanes and by six straightening vanes a short distance downstream of the fans. Tabs on the straightening vanes make possible very accurate adjustment of the airflow.

Basic unit of the fan power system is a variable-speed d.c. motor of 2,000 hp., supplied by a motor-generator set. Power requirements beyond the capacity of the basic unit are supplied by an a.c. variable-speed induction motor having a wound rotor and slip rings, and a short-time capacity of 10,000 hp. Speed and torque of the latter are adjustable by means of a liquid rheostat slip regulator.

The three model-support systems are types commonly used in wind tunnels, their special features resulting largely from the necessity that they be mounted on the movable carts, yet permit easy connection to, and separation from, the metrical system. This is accomplished by a jacking system acting on the four legs of each cart, the floor of which comprises the bottom of the working section.

When a loaded cart is in position, it is lowered electrically by the jacks until the model and its supports are resting on the metrical or force measuring system. Jacking is continued until the cart is disconnected from the model and is attached to the tunnel structure. Upon completion of a test the connection with the metrical system is broken at disconnect plugs, and the jacks disconnect the cart from the tunnel structure and pick up the model supporting system. Then the cart, driven by motors on the frame, moves out of the working section on rails.

The metrical system, which weighs more than 50,000 lb., is entirely contained within the structural shell of the tunnel and operates at pressures both above and below standard atmosphere. The lowest member of the system is a triangular frame resting on three supports in the bottom of the spherical shell surrounding the working section. Between the main frame and these supports are load measuring-capsules.

On the upper surface of the main frame are three circular, flat pads upon which rests a large ring which is accurately machined flat on both top and bottom surfaces. During operation, oil is pumped into the pads, supporting the ring on a thin film of oil. The dynamic form of oil support is similar to that used on the 200 in. telescope on nearby Mt. Palomar, and was chosen because of its extremely low coefficient of friction.

Horizontal forces on the airplane model—drag or cross-wind—are applied to the metrical system and transmitted to the large ring which, unless restrained, would slide on the oil pads. The ring is restrained by a drag link and two side force links which, in turn, are connected to the main frame through force-measuring capsules.

The drag link, running along the tunnel axis, measures drag directly. The two side force links lie perpendicular to the tunnel axis and are so arranged that the sum of the force increments on the links gives the crosswind force on the model.

In order to rotate a model in yaw, a vertical axis is established on the large ring and the whole ring is rotated by means of a remotely controlled worm

and gear drive with the large ring rotating on the flat pads of the main frame. The worm gear housing is connected to the main frame through the side force links, and is stabilized by them.

Resting on top of the large ring are three additional oil pads. These are spherical in shape and have as their center the center point of the tunnel, the midpoint of the line connecting the top of the two main model support arms. On these spherical pads rests a moment table, through which all of the model forces and moments pass—transmitted through the pads and taken out as previously mentioned. The moments would tend to make the moment table rotate in the spherical oil pads, so restraining is achieved by means of links between the table and the ring, each link being connected to a force-measuring capsule.

Along the axis of the tunnel one link is used to measure the model pitching moment, and across the tunnel axis two links are used, spaced some distance apart. The sum of the forces in these two links is a measure of the rolling moment, while the difference gives the yawing moment on the model. The spherical oil pads are double acting and thus form a spherical cup which completely restrains the model.

The top of the moment table is the line of separation between the metrical and suspension systems. Having the system level is of extreme importance to avoid errors in drag force readings. Through the use of tiltmeters the pads are kept level to 1 part in 200,000. Thickness of the oil film in the pads is also recorded in the control room because that, too, is involved in keeping the system level.

The force indicating system is a new application of the Southwark-Tate-Emery method of hydraulic weighing and remote indication of forces.

Essentially, the weighing system consists of nine new-type Emery capsules in the suspension system. The Emery capsule is primarily a rigid cylinder and piston unit having a 0.10-in. clearance and less than 0.002 in. stroke. Forces exerted on the capsules are balanced by hydraulic pressures developed within the capsules, and the resulting pressure changes are transmitted to the indicating system.

Hydraulic connections from the weighing sides of the capsules transmit pressures to the sensitive elements in the Tate-Emery indicator cabinet in the control room. Combinations of pressure-sensitive elements in each indicator permit weighing pressures to be added, to give the sum, or subtracted to give the difference of the pressures due to forces being exerted in the tunnel suspension system.

Specially developed automatic measuring and recording machines, presented to Cal Tech by International Business Machines Corp, permit continuous display, in true numerical form, of test data, also automatic recording of such data by printing on a work sheet and by punching in record cards Subsequently the cards are processed rapidly by IBM standard equipment to apply mathematical corrections and to transform the test data into dimensionless coefficients for study by aerodynamicists

Nine IBM followup units are provided, seven being applied to weighing gages which measure the dynamic pressure and the forces and moments exerted on the model airplane as it is supported in the tunnel's windstream. The remaining units are associated with receivers of autosyn telemetering devices which indicate the angular settings of the model with respect to the windstream

Follow-up units applied to the weighing gages determine settings by measuring linear motion to 1/10,000 in Those applied to autosyn telemetering receivers determine settings by measuring angular motion to 1/100 deg The follow-up units measure electromechanically with the aid of electronic tubes at a rate of one or two measurements per sec These measurements are electrically translated into digit representations The devices receiving digit representations in turn electrically control presentation of digits on lampbanks in the console wall of the control room Such digit representing devices also electrically control recording operations upon depression of record buttons Printing and punching of more than 80 columns of figures can be done in less than 3 sec.

Certain data relating to a model plane may remain relatively fixed in value throughout a series of tests. These data may be set up on keyboard units, invented and developed by IBM, and which electrically control the display of numbers on the lampbanks and data recording by the printer and the punch Each keyboard unit handles a single column of numbers and can be associated with other units to form a multicolumnar structure

To simulate true flight test conditions, certain models will be equipped with high speed electric motors driving scale-size propellers running at tip speeds equivalent to those of actual flight- For this purpose the tunnel is equipped with a system of high frequency power supply, regulation, and control, together with electric torsion dynamometers and wide range power metering equipment for model motor calibration

Laboratory facilities include two

model shops, a machine shop, sheet metal and wood shop, and dynamometer room, all on the second floor. A monorail system with two 3-ton hoists connects them all with the loading well where models are unloaded from delivery trucks. By means of an elevator section of rail the hoists may be run directly into the tunnel sphere.

On the ground floor is an engineering design room, blackline print room, photographic dark room, library, stockroom, computing room, conference room, administration office, and director's office.

The tunnel building itself provides space for stock materials, such as steel plates, bars and shapes, pipe and conduit, a welding shop and mechanical maintenance shop, carbon dioxide storage tanks for fire protection, and storage space for miscellaneous hoisting equipment, scaffolds, spare fan blades and other items.

Facilities and equipment provided for model tests and tunnel calibrations include four 48-in. mercury micromanometers, multiple manometers, Recordak viewer, hinge moment and strain gage reading equipment, etc. For calibration of tunnel flow there are a complete set of survey rakes and probes with pitot tubes and yaw heads to survey the entire working section, a 48 ft. static pressure tube, and a 12 ft. span and 8½ ft. span symmetrical section steel calibration wing.

Aviation and Civilization

(*Continued from page* 108)

the technical development of aviation will be greater in the next ten years than in the past, and that we must foresee and anticipate this development to a considerable extent in order properly to evaluate the fields of usefulness of aviation in the future.

Let us appraise several fields of human relations to determine where aircraft can contribute positively to progress; to learn the place of aviation in civilization. All of the fields selected here, and there are undoubtedly others, are to some extent interdependent and overlapping, but the samples given should clearly expose the possibilities.

Economic Uses

This science treats of the production, preservation and distribution of wealth. Each of these involves employment, which has prompted me to prepare a forecast to indicate how many jobs aviation should provide in one country, the United States. The attached table, Fig. 3, provides an estimate for a period eight to twelve years after the war. Though even in a

decade there is a great drop in employment from wartime peaks, there still appears to be a really important contribution to peacetime economy indicated, with more than twelve times the number of persons employed in aviation as were so engaged just prior to the war.

The figures of the table include so-called "grass roots" employment, that is, jobs outside the aircraft industry, such as are involved in mining, fabricating and otherwise preparing the materials used in aircraft construction, supplying tools for aircraft factories and other similar services.

There are a great many direct services which the airplane can render that will find their places in our economic life of the future, and, of course, the list will be supplemented by many others which have not even occurred to us as yet.

First there is so-called taxi service, which may be used extensively in transporting persons and goods from small communities to main stops of trunk lines. Many feel that this form of transportation may be found more economical and therefore more extensively used than small feeder-line services operating on a scheduled basis.

Then there are a great number of charter services for which the airplane is admirably adapted, such as crop dusting and insecticide spraying, aerial planting, spotting services of various natures, such as fire, oil line breakage and fish locations; equipment dropping to furnish needs of persons or communities in isolated locations; and aerial photography, serving a multitude of uses, such as laying out golf courses, estates and communities; and preparation of maps useful in crop planting, soil conservation and flood control.

There are also the obvious services pertaining to aviation itself, such as pilot training and aircraft maintenance and servicing.

One of the most promising uses of the airplane and the one most important from the standpoint of world economics is foreign commerce. When the airplane finds its proper place in this field, and when confidence in the hoped-for world security organization is established, there will be no need for the uneconomic measures of self-sufficiency which are so paramount in the minds of many at this time.

The interdependence of nations in our machine age is becoming more and more apparent. For example, an automobile manufactured in the United States uses materials normally obtained from nine locations in widely scattered sections of the world. Even

a telephone requires materials from seven This all points towards the economic unity of the world

Obviously, transportation is part of the general economic structure, and the place in which the airplane can play a basic role Speed of transportation represents a yardstick for the progress of civilization This speed may, perhaps, in the immediate future allow us to accelerate the tempo of commerce and industry as to catch up economically and socially with the time lost and the material destruction of the war The tremendous activities of air transport services in the conduct of the war are readily susceptible to transfer to uses essential to rehabilitation and readjustment, involving the transportation of food, medicines and people

The prospect of such a major contribution is emphasized by the existing trans-Atlantic flying, amounting to a four-engine plane flying one way or the other each 15 min in the service of the U. S. Air Transport Command alone. Any medium of transportation which finds geographic conditions no barrier must become of major importance

The factor of speed, which, in addition to independence of ground or water barriers, is the most important contribution the air carrier has to make to transportation, must in itself be reckoned with when forecasting increases in air traffic in the future It is not appropriate merely to extrapolate past performance in order to determine future achievement.

Whereas within the aviation industry in comparing individual airplanes, a formula of efficiency such as cruising speed multiplied by pay load and divided by some function of cost is appropriate, it is believed that when comparing different media of transportation with different orders of speed in connection with prognostications of future traffic, it is necessary to give further weight to this speed factor possibly by raising the cruising speed term to the second power The advantages of air transport will engender additional traffic not possible without the presence of the greater time-saving involved when traveling by air (From the engineering standpoint computations have shown that it is well worth while to increase the cost of a given transport plane by well over $1,000 if by so doing its cruising speed can be increased one mph)

The increase in air traffic will not, it should be stated, be at the general expense of other means of transportation The whole tempo will be so raised as to carry along with it added traffic best suited for transportation by rail or steamship, although the relative

proportions of types of cargo carried thereon may be substantially altered.

On the accompanying graphs are shown trend curves indicating U. S. air transport statistics for the ten years prior to the war, with extrapolations estimated for the next decade. Although statistics for war years are given, these, obviously, must be discounted, as traffic was abnormally large and equipment greatly reduced.

Revenue passenger load factors which had stabilized at about 60 percent just before the war rose to about 90 percent during the war period and are expected, after the peace is restored, to become reestablished at about 65 percent. Average length of trip for passengers on U. S. domestic airlines before the war was about 400 mi.

Fig. 4 gives passengers carried by U. S. domestic and international air carriers and shows prospect of transporting about 20 million per yr. by 1955. Fig. 5 indicates an increase in passenger miles, 1 billion in 1940 to 12 billion in 1955. An interesting trend of airline passenger miles compared to Pullman is given in Fig. 6. It is estimated that the prewar 10 percent will increase to 50 percent in the next decade. Statistics relating to mail and express are shown in Fig. 7. The anticipated acceleration in express traffic which will equal mail tonnage by 1951 is emphasized as an indication of the decreasing importance by the mail subsidy in air carrier economics.

The passenger fare trend is given in Fig. 8. The present 5c per mi. tariff should drop to 3c in ten years. Forecasting cruising speeds is somewhat of a risk because of the tremendous developments anticipated and previously described. Yet a trend curve bringing these speeds to 300 mph on the average by 1955, as given in Fig. 9, are certainly reasonably sure of attainment and admittedly will be exceeded in many specific instances. On Fig. 10 statistics indicative of improvement in safety are given in terms of passenger fatalities per 100 million passenger mi. flown. This rate at 1 per 100 million is hoped for soon, with losses at less than this number the rule after 1950. Finally on Fig. 11 the trend in operating efficiency is shown. Improvement is directly proportional to ton-mi. capacity pay load per hp./hr. Substantial and continuous improvement is anticipated.

One may ask, however, "What of the prospect of cost reductions of such magnitude as to bring air travel within the reach of the masses of population?" The trend of statistical information as given above is reassuring in this regard. Whereas for domestic air transport operations in the United States

in the 1920's costs on a capacity load basis were of the order of 50c. per ton mi., these had by the end of the 1930's decreased to 30c. per ton mi., and may, on the basis of civil transport planes now used by the military service, soon after the war drop to figures of the order of 20c. per ton mi. for passenger carrying, and 10c. or 12c. for carriers of cargo only.

It would therefore appear reasonable and has in fact been estimated, that during the 1950's we may look forward to cost for passenger carriage on a capacity load basis of the order of 15c. and for cargo of 8c. or 9c. per ton mi.

When these figures are translated into fares and tariffs by considering load factors of 65 percent or 70 percent and reasonable profits, it would appear justifiable to expect that during the 1950's passenger air transportation charges of 2½c. per mi. are within the realm of possibility, with express air transportation at rates of the order of 15c. per ton mi., thus comparing favorably with rail travel without taking due account of other very real savings (salary, meals, etc.) attendant to reducing intransit travel time. Certainly passenger travel at 3c. per passenger mi. and express transportation at 20c. per ton mi. is assured.

Forecasting ocean travel rates is difficult unless specific trips are taken into consideration in order that the factor of range so detrimental to cost economy may be accounted for. Recent investigators have indicated the possibility of round trips to England from the United States at figures of the order of $200, or 3c. per passenger mi., and several companies in the United States have actually forecast and published rates not greatly exceeding those figures. I believe these are somewhat optimistic. But even at some increase from this to such a round-trip cost as $300, which is certainly attainable, over-ocean travel may well approach the almost astronomical figures that some authorities have recently predicted.

Although it is probable that air transport will be utilized for the carrying of passengers, mail and express for the most part, there are possibilities for carrying freight, although probably not commodities of a bulk nature, i.e. those of low value per ton. The greatest potential here lies in supplying the needs of backward and undeveloped regions where other means of transportation may take weeks or months as compared to hours when carried by air.

It is anticipated that express carrying will advance by leaps and bounds after the war. Whereas at present the proportion of load carried by the domestic airlines of the United States

is 75 percent for passengers, 17 percent for mail and 6 percent for express (with 2 percent for other uses), it is reckoned that the percentage for express will increase to a point where it will approximate that devoted to mail, even though the latter should itself be substantially increased by virtue of the probable eventual removal of any mail tariff surcharge

For over-ocean traffic the percentage devoted to mail before the war considerably exceeded that for passengers It is believed possible that this disparity may lessen after the war

Consideration should be given to the factor of population mobility, and I will close this section with a brief reference to the private plane or the personal aircraft In evaluating the effect which such planes may have on city planning, full account must be taken of the tremendous change in our way of life which will be occasioned by the roof-top landings to which reference is frequently made, though its significance is seldom fully appreciated

If the helicopter should come into its own, as many expect, so that real masses of people could be moved to their places of business from their residences by air, the situation of road congestion would be so altered as substantially to affect the whole architectural arrangement of our cities Also the possibilities of locating residence sections farther from metropolitan business centers open vast vistas for the city planners. Recreational possibilities will be greatly enhanced by this greater mobility.

Mexico Girds for Air

(*Continued from page* 187)

of his country, likes to travel, and can be seen on all types of transportation, from airplanes on down, moving from one end of the Republic to the other, either for work or to visit relatives He is seen, on trains or buses, carrying his whole household with him, including not only innumerable children but also fowl and an occasional pig or two, and with bunches of bananas, fresh and dried meat, fish, and other victuals in the baggage rack He frankly admits that the airplane intrigues him, hence he'll fly when possible, if he has the money available, in which case he puts on his best Sunday clothes and is quite obviously thoroughly at home and enjoying himself

However, this everyday Mexican has heard of various accidents to overloaded single-engined airplanes, and he is beginning to insist on larger, modern equipment with two or more engines. He also wants better air-

ports, additional safety facilities, and more convenient connections. Even so, he has no objection to getting out to the airport at 5 A. M. to be able to do his business in one day, because in most towns everything closes for the day by 1 P. M.

The all-day train connection, always leaving early in the morning, necessitates his allowing three days, while by air he might be able to get home in one-and-a-half or even one day. The Civil Aviation Department, in its drive for modernization is therefore doing exactly what the average traveler in Mexico wants, and the obviously higher cost for the operator will be offset by increased travel and subsequent higher income.

The situation outlined above affects not only passenger transportation in Mexico but also the shipment of goods by air. Mexico is a good example of a country where cargo operations, even at rates comparable to U. S. air express, have a greater immediate chance of success than in the United States where excellent rail connections are so common.

On Mexican railroads, express and freight rates have increased many hundred percent over the past four or five years, and freight cars are too few to carry the merchandise awaiting shipment. In addition, as can be seen from the accompanying map of the railroads, the routes are circuitous. Freight to the important Pacific port of Mazatlan takes an average of four weeks from Mexico City, while the railroad passenger can make the same trip in 34 hr. In addition, the railroads have the bad habit of losing boxcars for weeks, after which they suddenly turn up in some out of the way spot.

Such a condition makes air cargo and air express attractive to the Mexican businessman, and even at the relatively high rates now in force (running as high as $100 per ton-mile in isolated sections of the Republic) shipments by air are of considerable volume. Unfortunately, the only exact figures available are for shipments out of the Federal Airport at Mexico City. These show that in Dec. 1944 loads averaged 940 lb. per flight to Merida, 430 lb. to Los Angeles and over 500 lb. to Guatemala. Totals of loads carried during that month were, respectively, 139,000, 52,000, and 63,000 lb.

Another factor which affects all travel and shipment by air is, of course, the isolation of many important parts of the country, often only reachable by airplane. Among these areas are the Yucatan Peninsula and virtually the entire southeastern section of the Republic—both regions which are becoming more and more important in Mexico's general business economy.

In such sections virtually all living necessities are transported by air—from food and drinking water to laundry for the more wealthy inhabitants. Even for certain fruits and vegetables the air cargo possibilities in such areas are excellent, despite the rates, for lack of surface transportation has yoked many of the large producers with losses as high as 80% of their entire crop in a single year, while by air much of it could be distributed. Also, costs of such items in sections where shipping facilities are few and far between are high enough to make their air transport feasible at 40 or 50 U. S. cents per ton-mile still enabling sale of these superior fresh products at prices from 25 to 30% below those shipped by other means.

Difficulties, mainly in problems of terrain, indicate that real improvement on surface transportation is many years off, hence it is the consensus of Mexican experts that the upswing in internal air traffic will continue. However, these observers feel that the time has come to put a halt to the promiscuous issuance of new permits. They believe that the period of stabilization of the Mexican air transport picture has just started.

Restrictions on foreign capital and control have become much stricter, an effort being made to halt the inflow of foreign investors who are looking for temporary investments during the clean-up period in Europe. Mexico thus seeks to prevent disastrous blows to its economy such as if many millions of *pesos* were suddenly withdrawn. These restrictions are naturally also affecting new airline enterprises and, as stated before, requirements for the operators themselves have become conducive to safer and sounder airline operations.

As matters stand now, there is a decided competition shaping up. On one side is Pan American Airways (including its interests in CMA and Aeronaves, with some 14,000 mi. of important routes in all) and on the other such operators as LAMSA, Aero-Transportes, Braniff, and Azteca (with among them more than 21,000 mi. of routes).

It would seem that the latter lines—mostly U. S. controlled, as stated earlier—would need to institute some cooperative plan merely to come out even in the battle with Pan American, whose strong status is well known. On the other hand, that Pan American is becoming restive about the unquestionably powerful newcomers appears indicated by its sale of approximately a one-third interest in CMA to a group of important figures in Mexico. This move might be interpreted as a means

calculated to "strengthen the front."

In the final analysis, however, little more than a practical neutrality is to be expected from Government circles, where it is felt that this competition of interests will ultimately improve air services in the land, to the benefit of every Mexican concerned.

Somewhat on the outskirts of this line-up stand three other operators, Panini, TAMSA, and Comunicaciones Aereas de Veracruz. It is noted that both Panini and TAMSA have for some time been for sale to the highest bidder. TAMSA is considered to have more to offer than Panini, including a good air cargo route along the Gulf Coast from Merida to Matamoras just south of Brownsville. Comunicaciones Aereas de Veracruz, which recently absorbed another local system, is known to be talking business with TACA, and the possibility of an outright sale is looming.

Between them, therefore, the eight companies discussed above (counting Pan American and satellites as a single unit) control nearly 43,000 of Mexico's total of 52,700 mi. of certificated air routes. After deducting the 3,400 mi. operated by such lines as American, Braniff, and TACA there are but 6,600 mi. of routes left, to be divided between about 20 operators. Little wonder therefore that it is generally believed that Mexico will eventually have five or six foreign airlines operating over its territory, and not more than ten domestic operators.

In a situation similar to that in which the United States found itself 15 yr. ago, Mexico stands at the aerial crossways, waiting with more than passive interest for the really first class aerial passenger and cargo operations which it needs to fully develop its resources commensurate with its broad potentials.

Book Reviews

(Continued from page 229)

from its discovery in China centuries ago to modern wartime developments in robot, bazooka, and jet-propelled plane. Treatment envisages various key possibilities of rocket power in future.

INDUSTRIAL ORGANIZATION AND MANAGEMENT, by Lawrence L. Bethel, Franklin S. Atwater, George H. E. Smith, and Harvey A. Stackman, Jr. McGraw-Hill Book Co., N. Y. C. 798 pages, text, illustrations, graphs. $4.50. This work is designed to prepare students for advanced work in methods, cost, industrial relations, budgeting, production control, marketing, office management, etc. Volume is divided into four principle sections: American Industry, Organization of Industrial Enterprises, Operation of Enterprises, and Coordination of Enterprises.

THE AIRMAN'S ALMANAC, 1945. Edited by Francis Walton. Farrar & Rinehart, New York City. 512 pages, text. $1.00. This handy book is described as containing "1001 facts on world aviation." Rules, routes, records, operations, airports, flyers,

planes engines, history, law, diet, aids medicine, dances, aviation, etc. are treated. For several years, Editor Welton handled aviation news for the **New York Herald-Tribune.**

MANAGEMENT AT THE BARGAINING TABLE, by Lee H. Hill and Charles R. Hook, Jr. McGraw-Hill Book Co., New York City. 300 pages, text, bibliography. $3.00

Treatment of collective bargaining giving viewpoints for management and its representatives on principles involved knowledge of agreements and steps in negotiating them

Review of Patents

(*Continued from page 229*)

signed for method to fixedly secure transverse member in a predetermined control horizontal position mannit panels in substantially vertical position on each side thereof and spaced therefrom; make service connections and translate panels into engagement with transverse member while preserving initial horizontal alignment and making permanent structural connections.—2,374,894. filed June 16, '43; pat. May 1, '45. W. F. Floch and G. E. Scarlett, assignors to Ford Meter Co.

Propeller Pitch Control is intended to be effective in turning blades beyond normal pitch range are by development of higher fluid pressure than that of engine-driven pump, the higher pressure being produced by fluid compressor or pump driven through independent means.—2,375,028. filed Sept. 7, '35; pat. May 1, '45. R. M. Nardone, assignor to Bendix Aviation Corp.

Airplane designed to utilize all air from slipstream for lift and also to have maximum lateral stability embodies fuselage having forward end in form of convergent tunnel on underside, the laterals of fuselage rear being extended in winglike form.—2,375,366. filed Feb. 8, '41; pat. May 8, '45. J. Weguel.

Wood or Plastic Propeller Blades are adapted for use with variable pitch control mechanism by utilizing metal sleeve with internal and external threads for screwing into a cylindrical groove in blade to effect connection to control mechanism.—2,375,326. filed July 18, '43; pat. May 8, '45. J. R. Reché and P. A. Reché.

Lift Increasing Means for takeoff or steady flight embodies wings with detachable portions which can be discarded when aircraft is airborne. Each wing is provided with a detachable tip secured by hook attachments with provision for effecting release under the pilot's control.—2,375,428. filed Jan. 28, '43; pat. May 8, '45. M. J. O. Lobelle, assignor to R. Meicom Ltd.

Control System for rotary wing craft is designed to provide rapid pitch increase for propulsive airscrew, following rotor acceleration period so as to establish translational flight speed at rapid rate and thereby avoid loss of altitude at end of direct takeoff maneuver.—2,376,465. filed June 19, '41; pat. May 8, '45. H. S. Campbell, assignor to Autogiro Co. of America.

Slotted Aileron and Flap operating mechanism, housed within wing profile to offer little resistance to airstream, projects movable surface rearwardly and downwardly to create a slot of desired width and shape.—2,375,310. filed June 4, '41; pat. May 8, '45. J. R. Allen, assignor to Consolidated Vultee Aircraft Corp.

Available Patent Licenses Listed

Recently announced by U. S. Patent Office is inauguration of a new service intended to bring to the attention of the public those patented inventions under which owners are willing to grant licenses. A *Register of Patents Available for Licensing* will be maintained in the Patent Office, and patents recorded on the register will be available for inspection in Washington, D. C. Lists of the patents will be published in the *Official Gazette of the Patent Office*

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Snap! make...Snap! break

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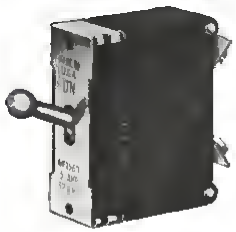

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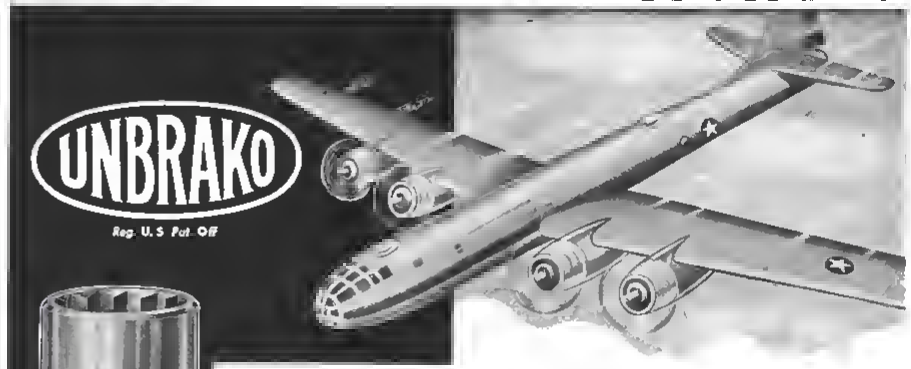

"UNBRAKO" SCREW PRODUCTS CAN BE RELIED UPON

FIBRE PLUGS

FIG. 1

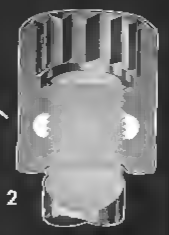

FIG. 2

The "UNBRAKO" Internal Wrenching Lock Nut is a superb and officially approved safety nut for primary connections in aircraft. Two vulcanized fibre (Fig. 1) inserted through the body of the nut provide the locking feature. Fig. 2 shows how these plugs contact four threads of the bolt, assuring an absolutely dependable locking grip.

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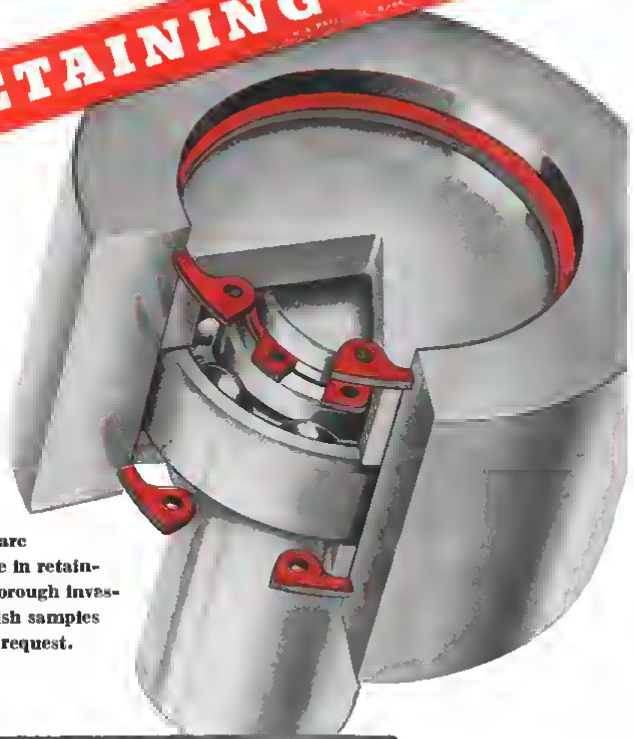

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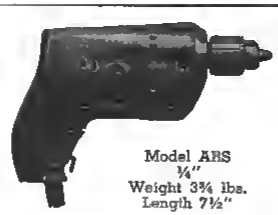

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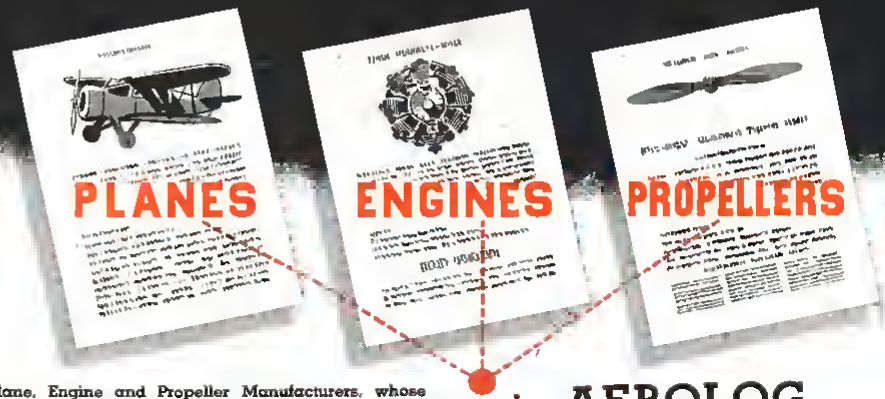

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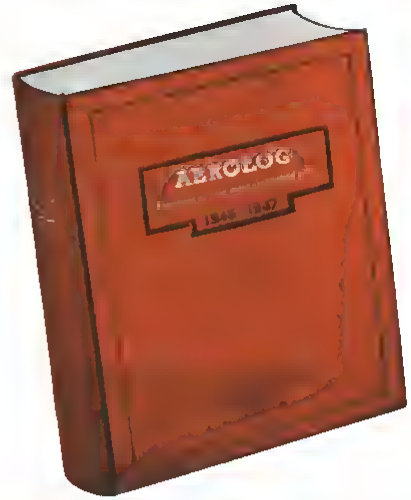

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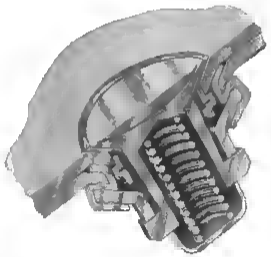
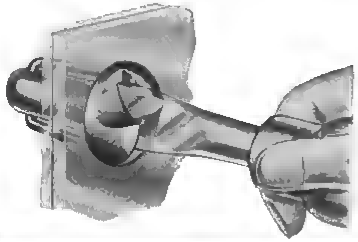


QUICK-LOCK

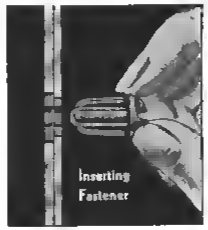
Only initial loads are carried by helical spring. Increased loads are taken by solid supports, assuring minimum deflection. 90° rotation locks or unlocks fastener. Stud is self-ejecting when unlocked. No special tools required for stud installation.

Standard studs can be used with air and water tight receptacle assemblies. Handles large range of material thicknesses by varying depth of receptacle-installation dimple.



SPRING-LOCK

An inexpensive one-piece fastener—simple to install, self-adjusting for various thicknesses. Locks and unlocks with a quarter-turn in a 90° clockwise rotation. Can be permanently installed for use as a blind rivet.



HOW SIMPLE

LOCK NUT

Double Duty Safety Nut—Lock Nut and Stop Nut.

AS A LOCK NUT. One end of safety ring engages nearest serration on bolt thread. With 7 serrations there are 14 locking positions per revolution.

Safety Ring in unlocked position on long thread. Serrations on the bolt threads can be cut by a simple broaching operation on a production basis in a fraction of the time it takes to drill a cotter pin hole.

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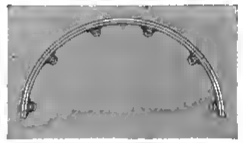
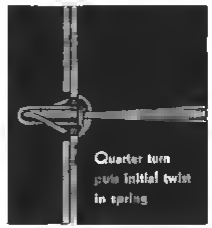
Oval-Head Stud and Plate-Type Receptacle. Plate-type is interchangeable with all standard A-N Receptacles. No special tools required.



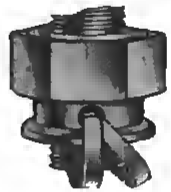
Tapered principle is particularly valuable in assembling curved sheets such as engine cowlings.

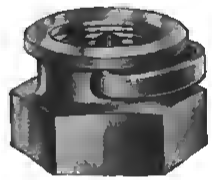
Adjustable fastener, using one stud and one adjustable receptacle fastens material thicknesses ranging from 1/32" to 5/16". By reversing flange, increased range 5/16" to 3/4" can be obtained.



IT IS TO INSTALL THE SPRING-LOCK FASTENER

AS A STOP NUT. Can be used without serrated thread, providing close adjustment. When nut is tightened and safety ring snapped in locked position, ends of ring bite into thread, providing stops for nut.



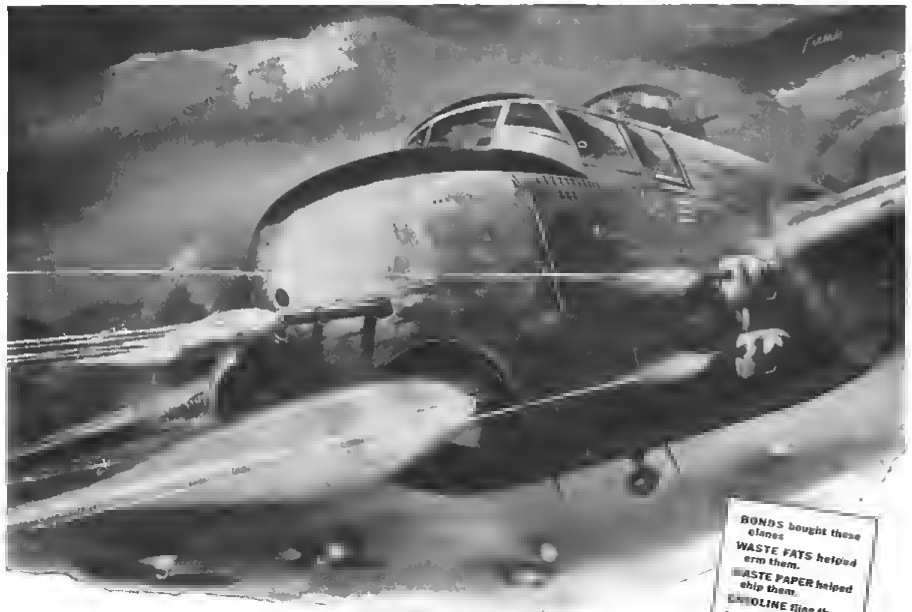


One Safety Nut for all purposes. Assures highest degree of permanence and safety—reduces assembly time.

U. S. AND FOREIGN PATENTS APPLIED FOR

SIMMONS FASTENERS

SIMMONS FASTENER CORPORATION • 1753 NORTH BROADWAY, ALBANY 1, N. Y.

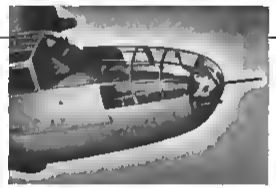


BONDS bought these planes
WASTE FATS helped arm them.
WASTE PAPER helped ship them.
GASOLINE flies them.
WILL YOU help deliver [illegible] squadron?

Jack of all Raids

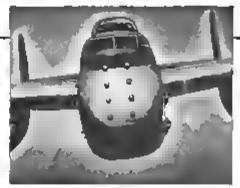
Target of opportunity, the long suit of any B-25 Mitchell, and when the target does not readily present itself, you can depend on American pilots to make the opportunity. Whether it's a bombing mission requiring pinpoint precision or busting up a jungle troop concentration with lawnmower efficiency, the B-25 takes them all in stride. To the Japs, this rugged plane is nicknamed The Flying Pillbox; to American pilots, it's the work horse of the Army Air Forces.

THREE MODELS OF THE B-25 MITCHELL—EACH DESIGNED FOR A SPECIAL TYPE OF COMBAT OPERATION



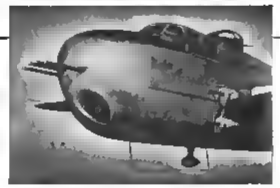
PINPOINT

This is the bomb-sight nose of a B-25 Mitchell. This model is used for pinpoint precision bombing from medium altitudes.



PENETRATION

B-25 Mitchell with eight 50 caliber machine guns in the nose. This model used for penetrating jungle undergrowth.



PUNCH

Famed 75 mm cannon nose of the B-25 Mitchell delivers knockouts to pillboxes, punches holes in Jap communications.

North American Aviation *Sets the Pace*

PLANES THAT MAKE HEADLINES ... *the P-51 Mustang fighter (A-36 fighter-bomber), B-25 and PBJ Mitchell bomber, the AT-6 and SNJ Texan combat trainer. North American Aviation, Inc. Member, Aircraft War Production Council, Inc.*

SINCLAIR POWER for WINGS to MEXICO

Flagship stop between San Antonio and Mexico City. Sinclair Aviation Gasoline is taken on at San Antonio.

As one of the major suppliers of fuel to Army and Navy Air Squadrons, Sinclair is proud to have introduced its aviation gasoline to commercial flying in planes of America's greatest air transportation company — American Airlines.

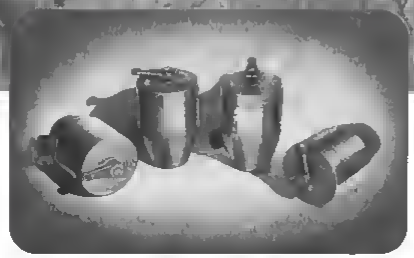
Sinclair Aviation Gasoline is *powering*, Sinclair Pennsylvania Motor Oil is *lubricating* American Airlines Flagships on their daily flights from San Antonio, Texas, into Mexico. Thus Sinclair-powered flight is now added to the hundreds of millions of miles of Sinclair-lubricated flight by American's Flagships.

Sinclair Aviation Gasoline will aid advancement of transportation on national and international airways.

SINCLAIR AVIATION OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

The Douglas A-26 Invader attack bomber, one of our fastest and most versatile tactical weapons. Photo courtesy Douglas.



Barber-Colman controls on the A-26 are four power units for remote control of carburetor heat and air filters.

BARBER-COLMAN CONTROLS

ON CARBURETOR HEAT AND FILTERS FOR THE A-26 "INVADER"

HIGH speed, easy maneuverability, heavy armament, and sizeable bomb load are the characteristics which make the Douglas A-26 "Invader" one of the most formidable additions to our Air Forces. This airplane was designed for service as a fighter, bomber, night fighter, torpedo plane, destroyer, strafer, or attack airplane, or any combination of these types. It is described as "extremely easy to handle, with well grouped controls, comfortable seating, and devoid of any vicious tricks." Among the controls are four manual switches, two for carburetor heat, and two for carburetor filters. These switches remotely position four Barber-Colman Power Units controlling the heat doors on the warm air supply for the carburetors to counteract icing conditions and the dampers on the air intake filters that keep ruinous dirt out of the carburetors and engine cylinders.

The Barber-Colman units are powerful, light in weight, dependable in operation, and function accurately and quickly to meet fast-changing conditions encountered in flight. These and various other Barber-Colman Control Systems are available for many aircraft applications. Complete engineering data on equipment to meet specific requirements will be furnished on request.

BARBER-COLMAN COMPANY
1221 ROCK STREET • ROCKFORD, ILLINOIS

1¾ Million Miles in 3 Years! *Equivalent to*

640 flights New York to Los Angeles logged by a Solar Manifold on American Airlines Flagships

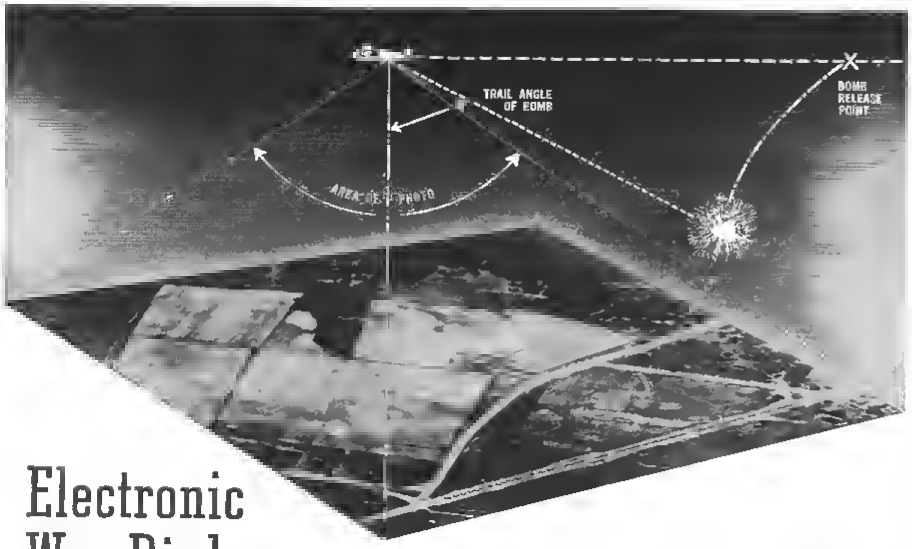
Over every battlefront as well as on the world's major airlines, Solar Exhaust Systems are recognized for their excellence in engineering design and for their precision of manufacture as shown in their remarkable service records.

Typical is the Solar exhaust manifold which American Airlines has had in service for over three years on one of their Wright G-102 engines in their Douglas (DC-3) Flagships. Through all weather conditions, this Solar manifold, in the hands of American's expert maintenance crew, has given more than 10,000 hours of notable service.

Solar skills will continue to solve problems in the elimination of hot gases, together with the utilization of waste heat energy, the control and transfer of heat and the production of products of high corrosion resistance.

SOLAR
STAINLESS STEEL PRODUCTS

SOLAR AIRCRAFT COMPANY SAN DIEGO 12, CALIF. DES MOINES 5, IA.

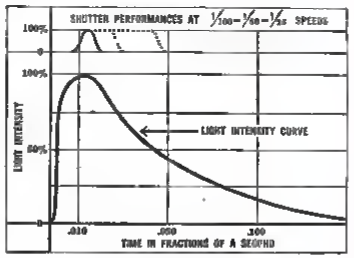


Electronic War Birds ... *that pry into the secrets of the night*

Night-time. A reconnaissance plane streaks over an enemy supply line. A flash bomb drops and explodes ... night turns into day ... a camera shutter clicks. And the secret of the long motor caravan, shown in the night photo above, is fully revealed.

How is it done? With electronic and mechanical precision skill. The plane may be flying at 1,000 feet, or 10,000 feet, or higher. A flash bomb is released to explode at a predetermined elevation. An electronic light-sensitive cell ... on a Fairchild Night Aerial Camera ... creates a voltage pulse in an electronic amplifier which causes the magnetic shutter to trip at the peak light intensity of the flash bomb. All elements of the camera and amplifier are so precisely coordinated that the entire action takes place over a timing range of 9 to 11 thousandths of a second. The action starts when the light intensity of the flash at the airplane is only a very small percentage of its peak brilliance ... and ends as the flash passes its peak.

Precisionized electronic and mechanical skill ranks Fairchild Aerial Cameras with the world's finest *professional* cameras — an achievement that is being paralleled in the production of aircraft sextants, radio direction finders, lead computing gun sights and other vital aviation equipment. *New York Office* 475—10th Ave., New York 18. *Plant* 88 06 Van Wyck Blvd., Jamaica 1, N. Y.



This is a typical flash bomb light curve and camera shutter synchronization chart. Precise electronic coordination of shutter action at the light intensity peak results in sharply detailed aerial night photographs.

Fairchild CAMERA AND INSTRUMENT CORPORATION

Professional AERIAL CAMERAS

DUPLICATING A GERMAN VACUUM TUBE IN 3 DAYS

Just behind the battlefront, a telephone system lay dead. The retreating enemy, hoping to return, had not blown it up, but had taken with them its vacuum tubes. To put it back to work, the General ordered 1000 new tubes — spot delivery.

A sample tube was flown back to the United States and brought to Bell Telephone Laboratories. It was of German design, different from any American tube in both dimensions and characteristics. Could it be duplicated soon? The job looked feasible. Within three days, try-out models were on their way to Europe. Three weeks later, Western Electric Company had made and delivered every tube. They were plugged in; vital communications sprang to life.

Vacuum tubes are an old story for Bell Laboratories scientists. Back in 1912 they made the first effective high vacuum tube. Three years later, they demonstrated the practical possibilities of tubes by making the first radio talk across the Atlantic, pointing the way to radio broadcasting. Since then, they have developed and utilized the vacuum tube wherever it promises better telephone communication — there are more than a million in your Bell Telephone System.

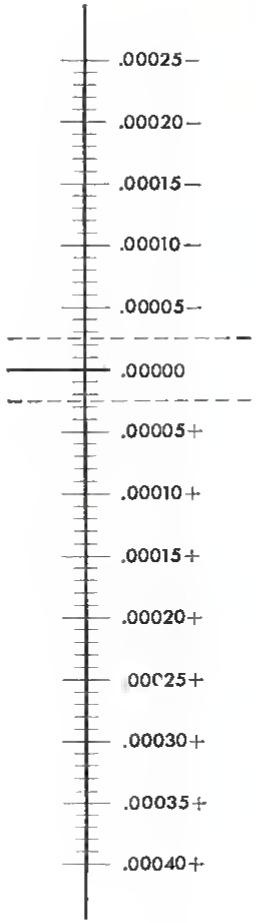
Today, Bell Telephone Laboratories is solving many of the toughest tube problems faced by the Armed Forces. When the war is over, it goes back to its regular job—keeping American telephone service the best in the world.

• This electrical replica of a heater-type pentode was made for use in German telephone repeaters.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for our Armed Forces at war, and for continued improvements and economies in telephone service

Mass Precision and "*ghost*" tolerances.



"Ghost" tolerances hover near the zero mark—these are tolerances in "quarter-tenths" and "millionths". To obtain such accuracy requires the proper machines, correct processes, skilled workmen, and gages to show the results.

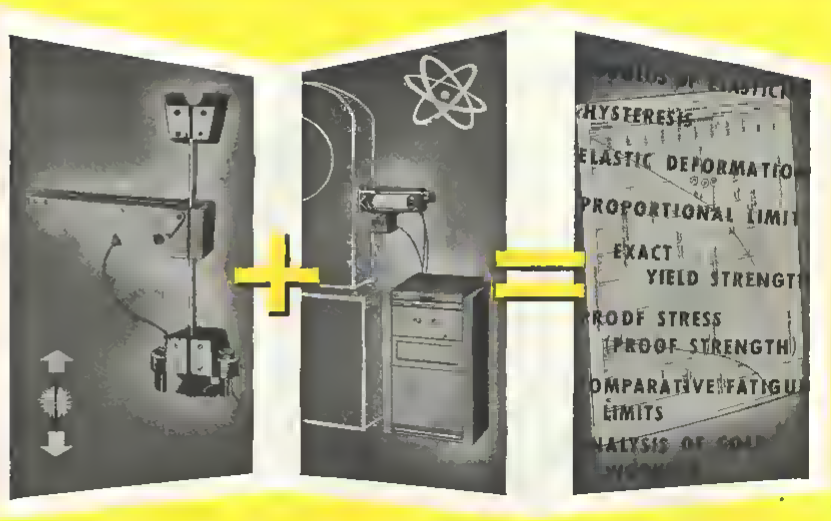
Nichols has all the factors necessary to produce parts to "ghost" tolerances—*and something more.* It has the knowledge (based on 40 years' experience) to produce these parts *in volume, at low cost.* In short, Nichols can manufacture "mass precision" assemblies for you that can be priced to meet competition When your work calls for "ghost" tolerances, call for Nichols.

A free copy of "Mass Precision" is yours for the asking.

W. H NICHOLS & SONS, 48 WOERD AVE, WALTHAM 54, MASSACHUSETTS

"Accurate" *Nichols*

PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION



TO THOSE COMPANIES WHO HAVE $2,000 OR MORE INVESTED IN A UNIVERSAL TESTING MACHINE

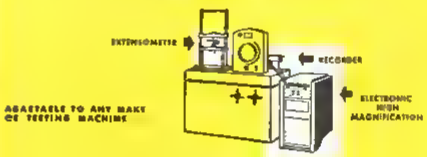
The addition of an Olsen Electronic High Magnification Recorder will increase its effective usefulness at least fourfold —

HERE ARE THE FACTS...

1. Any Universal Testing Machine without a recorder is limited in its function to measure accurately the ultimate strength, per cent elongation, and the approximate yield strength of the material being tested.

2. Any Universal Testing Machine equipped with an Olsen Electronic High Magnification Recorder — in the same time required to make a non-recorded test — gives the following additional essential information.

1 — Modulus of Elasticity
2 — Hysteresis
3 — Elastic Deformation
4 — Preportional Limit
5 — Exact Yield Strength
6 — Proof Stress (Proof Strength)
7 — Comparative Fatigue Limits
8 — Analysis of Cold Working



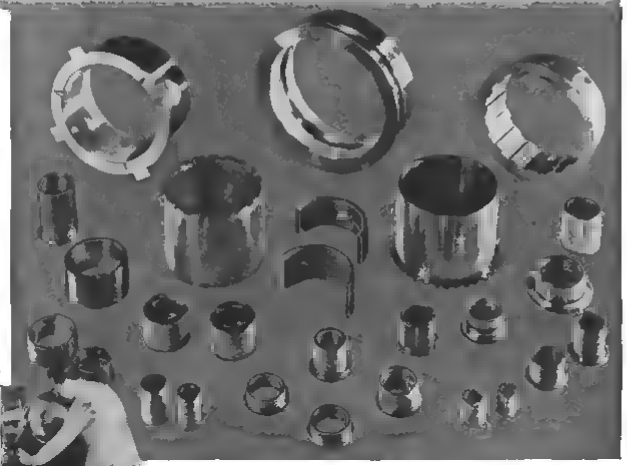
TESTING AND BALANCING MACHINES

OLSEN

TINIUS OLSEN TESTING MACHINE COMPANY
8400 North Twelfth Street · Philadelphia 23, Pennsylvania
Representatives:
PACIFIC SCIENTIFIC CO., Los Angeles, San Francisco, Seattle
MINE and SMELTER SUPPLY CO., Denver, Colo.

How an Old Name in Metallurgy Became

A BIG NAME IN BEARINGS



IN THE FIELD of metallurgy, as in every other business, three things contribute to industrial leadership: *engineering research, production skill, constant emphasis on precision and accuracy.* These are the reasons why Mallory metallurgical products have been famous for over a quarter of a century. They explain, too, why Mallory Bearings have found wide acceptance in the aircraft industry.

When airplane engines were stepped up in power, internal stresses were enormously increased. A more durable metal was needed for bearings—a metal, too, that was more heat resisting. Metallurgical Research found that silver was the answer to this problem, but silver was expensive and difficult to apply.

Mallory was able to surmount these obstacles by developing a method of electrolytically applying silver to base metal backings. Then, Metallurgical Research evolved special mass production methods.

Thousands of military planes today are equipped with Mallory Precision Bearings. Their performance under strenuous conditions suggests great possibilities for the peacetime future. The skill and experience that evolved these bearings are yours to enlist in planning post-war products. We are open-minded to outside suggestions: very much interested in the "special" problem. Write for Form B-1000

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

P. R. MALLORY & CO. Inc.

MALLORY PRECISION BEARINGS

FOR AIR COMPRESSORS • AIRCRAFT, AUTOMOTIVE AND DIESEL ENGINES • ELECTRIC GENERATORS AND MOTORS • ELEVATORS • FANS AND BLOWERS • GOVERNORS • HOME APPLIANCES • MACHINE TOOLS • PUMPS • RAILROAD EQUIPMENT • ROLLING MILLS • STATIONARY AND PORTABLE ENGINES • STOKERS • TURBINES

E. A. looks to their safety

The wartime assignment of protecting the lives and providing comfort for our fliers came natural to E. A. Laboratories. For thirty-five years our plants have been dedicated to the manufacture of products for safety and comfort.

The war necessitated a let down in the production of our peace time line. But there never was a let down in our thinking and planning for the return to peace and with it the resumption of shipments to our dealers. As the easing of restrictions makes this possible, E. A. will again be first in Quality, Profit and Delivery

E. A. LABORATORIES, Inc., BROOKLYN, N. Y.

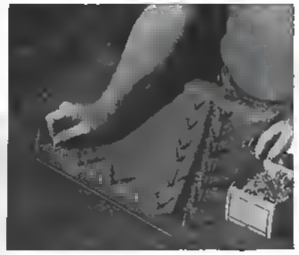
MAKERS OF AUTOMOTIVE, AVIATION, BICYCLE AND MARINE APPLIANCES

Greater airframe design flexibility

Here's a clear example of how Cherry Blind Rivets allow designing up to maximum efficiency rather than down to previous mechanical limitations. With Cherry Rivets, this assembly was strengthened with a plate, simply and quickly (the entire installation took 12 minutes). Without Cherry Rivets, a less satisfactory, slower, more expensive form of reinforcing would have been necessary.

PHOTOS COURTESY OF LOCKHEED AIRCRAFT CORPORATION

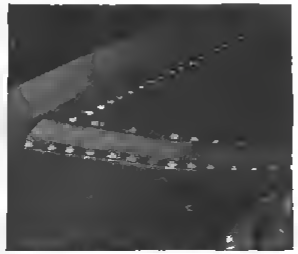
The cover plate stiffener makes this a blind application



Placing Cherry Rivets in drilled holes

"Pulling" Cherry Rivets with G-15RB pneumatic gun

Trimming stems flush to Cherry Rivet head



Completed installation—strong, easy, took only 12 minutes

This greater design flexibility results from such factors as these: Cherry Rivets upset from one side of any spot, blind or not, without any bucking. Small, lightweight Cherry Rivet guns reach hard-to-get-at spots easily and quickly. The smooth, easy pull with which Cherry Rivets are upset allows their use in soft or brittle materials as well as all sheet metals. Exceptional shank expansion allows hole size variations up to .008". Material thicknesses may vary as much as .062" for the same grip length rivet. (Both of these are factory-recommended tolerances. Even greater variations are possible.) Installed Cherry Rivets have shear values comparable with solid rivets.

For more detailed information, write now for illustrated Manual D-45, Dept. A-110, Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California

CHERRY RIVETS, THEIR MANUFACTURE AND APPLICATION ARE COVERED BY U.S. PATENTS ISSUED & PENDING

Cherry Rivet
Company
LOS ANGELES 13, CALIFORNIA

Aiding allied aircraft to fly higher and farther

1 FUEL TANK PRESSURE CONTROL VALVE Model FAZ An aneroid valve which prevents cavitation and vapor-lock in fuel system by maintaining a predetermined pressure in fuel tank under all flight conditions. Wt 1 lb. 2 oz. Overall, 4¼" x 5"

2 PRESSURE RELIEF VALVE. This non-adjusting valve assembly serves dual purpose of venting excessive pressures and admitting air, preventing negative pressures. Settings to customer's requirements. Wt 3 oz. Overall, length 3"; width 1½", height 1¾"

3 ALTITUDE COMPENSATING VALVE. Specifically designed to maintain given pressure on a system regardless of altitude. A vacuum relief valve is incorporated in case negative pressure develops in the system. Wt 15 oz. Overall, length 3"; width 2"; height 3½"

4 OIL PRESSURIZING VALVE Model SOV-1-3. A double action valve, maintains a predetermined pressure on oil tank preventing cavitation in system. Safety feature prevents vacuum developing in tank. Wt 6 oz. Overall, length 5⅞"; width 3"; height 2"

These and other Standair precision automatic engine controls for aircraft are more fully described in the 1945 edition of Aeronautical Engineering Catalog. Standair also manufactures aircraft lighting equipment (see 1945 A. E. Catalog), and sheet metal products. For complete details or information relative to application to your specific problems, write or wire.

Standard Aircraft Products Inc.
DAYTON 2, OHIO

BUY BOMBS BY BUYING BONDS

SALES OFFICES

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L. M. Payne Company, Inc., 417 Curtis Building, Detroit, Michigan
Hartwell Aviation Supply Co., 5417 Crenshaw Blvd., Los Angeles, Cal.
Hartwell Aviation Supply Co., Nurse Building, Kansas City, Kansas
Hartwell Aviation Supply Co., 608 North St. Paul St., Dallas, Texas

So sorry!

DIRECT HITS on the huge aircraft plant at Omura near Nagasaki are scored by the first wave of B-29's. More to come. *Official Photo U.S.A.A.F.*

The hell we are! The little yellow men up Tokyo way just can't seem to take a hint. Germany learned — the hard way. German top-ranking General Von Rundstedt freely admitted that Allied bombing had smashed Hitler's power to fight back.

But in Europe all we used were the "little" Fortresses and Liberators which could only carry three or four tons of bombs. The Superforts, however, tote up to ten tons. *And fast!*

The Japs are getting a tiny sample right now of the destruction these planes can deal out. If they were smart they would haul out the white flag now before they find themselves on the receiving end of 2000-at-a-clip bomber attacks.

But if they don't . . . they'll just have to take it. And dishing it out will be vast fleets of these powerhouse Boeing B-29's, for whose great Wright engines we at Chandler-Evans are proud to be turning out precision-built carburetors. And sticking to this job is the best way we know to help ram Hirohito's face down his throat.

CECO

CARBURETORS
FUEL PUMPS
PROTEK-PLUGS

CHANDLER-EVANS CORPORATION SOUTH MERIDEN CONNECTICUT, U.S.A.

ENGINEERS . . . PRODUCTION MEN

Get this New Free Book on BLIND RIVETING!

THIS comprehensive illustrated manual explains in detail the unique operating principles of the Huck Blind Rivet and the advantages provided by this design—advantages proved by wide application in aircraft construction and similar fields. Complete instructions and data are given for selecting the proper rivet length, drilling and dimpling the material, driving the rivets, and inspection of driven rivets from the accessible side of the work. Other sections cover operation of the rivet gun and removal of driven rivets.

Only HUCK Blind Rivets Offer *ALL* These Advantages

1. Positive shank expansion to fill the hole—assures a rigid, fatigue-resistant joint capable of withstanding vibration and reversals of stress
2. Bulbed blind head formation—pulls sheets tightly together, provides adequate surface contact between blind head and sheet, gives great strength and rigidity
3. Positive mechanical lock—rigidly and permanently locks rivet pin to sleeve, gives driven rivet a strength comparable to that of a solid rivet
4. Automatic pin break, flush with outer head—no trimming required
5. Quick, easy driving. Jaws of gun hold rivet rigidly centralized, rivet can't wobble, fall out, or move so as to cause improper engagement of the pin by the gun jaws. Complete driving operation is very rapid and requires only one operator
6. Simple and fast inspection of driven rivets—by merely examining the manufactured head on the accessible side of the work

Free illustrated manual gives full details

Written particularly for engineers and production men, this new manual will be of interest to everyone concerned with sheet metal assembly problems. Send for your free copy today—on your company letterhead, please.

Huck MANUFACTURING CO.
2480 BELLEVUE AVENUE DETROIT 7, MICHIGAN

NOW YOU CAN SALVAGE WORK PIECES YOU FORMERLY SCRAPPED BECAUSE OF BROKEN, EMBEDDED TOOLS

Typical set-up using drill press. Disintegrator "head" is chucked solidly in locked press; work piece is clamped firmly to table. "Head" does not revolve; will operate at any angle.

Drafto Metal Disintegrator

Model 2-A $295 Complete

The Drafto Metal Disintegrator is a compact, portable, self-contained unit designed to save dies and work pieces you formerly scrapped because of embedded tools. It disintegrates metal through the action of a rapidly vibrating electric arc, without excess heat or pressure.

Broken taps are removed by disintegrating the core. You take out broken drills by disintegrating the web. Studs and hardened pins are removed by disintegrating odd shaped holes.

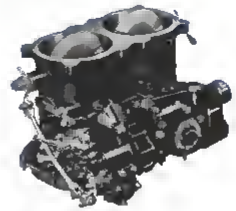
Finished surfaces, hardness of metal, and delicate contours are not affected, for disintegration takes place only where the electrode touches.

Drafto Metal Disintegrator requires no lengthy training period. It comes to you complete, ready to go to work, with its self-contained coolant tank and pump, and a supply of electrodes for $295. Manufactured by Drafto Corporation, Cochranton, Pa. Representatives in key cities.

WRITE, WIRE OR PHONE
FOR BULLETINS AND DETAILS
Address Inquiries to Dept. A.

WALTER J. GREENLEAF *Company*
NATIONAL DISTRIBUTORS
Pittsburgh 21, Pennsylvania

Stromberg Injection Carburetion carries the fight to the enemy



FOR TOP-FLIGHT PERFORMANCE

The Stromberg Injection Carburetor has considerably increased the *ceiling* as well as the range of fighting and bombing planes. And Bendix—with the finest research facilities in its field—continues to make improvements. Watch Bendix for the latest advancements in Injection Carburetion.

Fighters today travel as far as yesterday's bombers—*and one basic reason is Stromberg Injection Carburetion.* By automatically assuring the most economical mixture of fuel and air under all conditions of altitude, speed, position and temperature, these precision-built carburetors extract many extra miles from every gallon of gas. Standard equipment on the finest, fastest Allied fighters and bombers today, these products of Bendix Creative Engineering hold great promise for the commercial airlines of tomorrow.

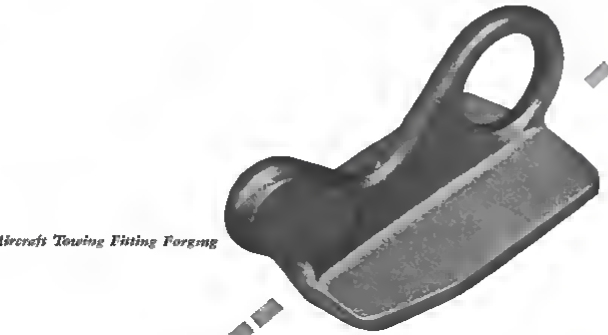
Listen to "MEN OF VISION" Sundays 7 P.M. E.W.T. CBS.

Bendix PRODUCTS DIVISION
BENDIX AVIATION CORPORATION
SOUTH BEND 26, INDIANA

PRODUCT OF Bendix AVIATION CORPORATION

an aircraft . . .
FORGING

designed to develop maximum metal quality



Aircraft Towing Fitting Forging

When aircraft parts are designed to take full advantage of the fibre-like flow line structure of wrought metals, then *metal quality* can be developed, by forging, in the exact degree required to meet a given service condition. The maximum **IMPROVEMENT OF METALS BY FORGING** involves the know-how of utilizing fully the fibre-like flow line structure to obtain high tensile and impact strength, toughness and fatigue resistance in simple, as well as highly stressed parts. Consult a Steel Improvement Forging Engineer, who is backed by 32 years of technical production effort, about the development of *metal quality* required to fortify your product for unpredictable emergencies.

Reference Data Booklet presents many new ideas on forgings and their applications in many different types of equipment. Copies available to engineers, metallurgists and executives.

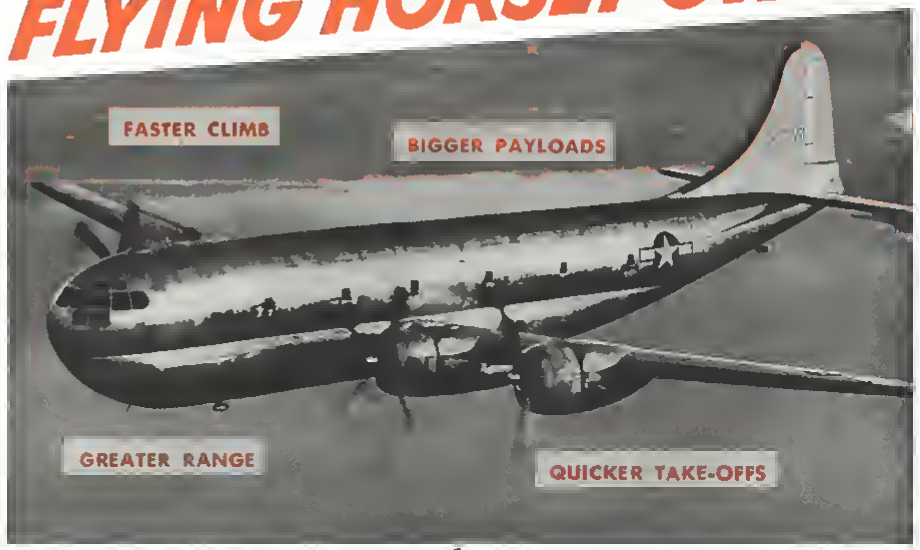
DROP FORGINGS

THE STEEL IMPROVEMENT & FORGE CO.

960 East 64th Street CLEVELAND, OHIO

From the World's Greatest Catalytic Cracking Program . . .

FLYING HORSEPOWER



● **COMMERCIAL OPERATORS:** All the power your planes' engines can take! That's what you get from *new* aviation *Mobilgas!* It's *Flying Horsepower*—from the same super fuel ingredients now giving our flyers great advantages in combat. Give your fleet this big lift to bigger payloads!

PRIVATE FLYERS: You're next for *Flying Horsepower!* This dazzling new power from gasoline will give you flight maneuverability you never dreamed possible! Right now, it's 100% war power. But soon *you'll* get Flying Horsepower performance — from a great *new* aviation *Mobilgas!*

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THE FINEST AVIATION GASOLINES FROM THE COMPANY WITH THE GREATEST CATALYTIC CRACKING EXPERIENCE AND PRODUCTION CAPACITY!

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MOBILOIL AERO—proved outstanding in flights the world over!

"INFORMATION PLEASE" returns from vacation September 10. Until then, hear Rise Stevens and Hollywood Music—Mondays 9:30 P.M., E.W.T., NBC

To Get the Benefits of Technological Advances in Felt

CONSULT AN AMERICAN FELT COMPANY PRODUCT ENGINEER!

So rapid have been wartime advances in Felt technology that you may not be fully benefitting by the many new developments and applications. The assistance of an American Felt Company Product Engineer may prove extremely valuable at this time.

These Felt specialists are familiar with the latest developments, both in our new and enlarged Research and Engineering Laboratory and in the field. They can furnish complete data and show you how to adapt new principles and techniques to your present or proposed Felt applications.

Now as always, the American Felt Company Product Engineer builds sales — on *your* continued satisfaction. Now more than ever before are his calls of immediate practical value. For advice on a specific Felt application or a general check-up on present procedure, please get in touch with the office in your locality. Expert, authoritative aid is an important part of American Felt Company Service to American Industry.

American Felt Company

TRADE MARK

General Offices. GLENVILLE, CONN.

New York; Boston; Chicago; Detroit; Philadelphia; Cleveland; St. Louis; Los Angeles; Seattle; San Francisco; Dallas; Atlanta

PRODUCERS OF FINEST QUALITY PARTS FOR OIL RETAINERS, WICKS, GREASE RETAINERS, DUST EXCLUDERS, GASKETS, PACKING, VIBRATION ISOLATION, INSULATION AND SOUND ABSORPTION FELTS

3 RESILIENT, *Rubber-Cushioned* ABRASIVE TEXTURES

WHEELS • BLOCKS • STICKS • RODS

A Complete Line In Each Texture *for* Close-Tolerance, Precision Manual and Machine

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Brightboy Tuff-Tex

Brightboy TUFF-TEX

Tougher texture, for finishing hard metals. The tougher binder accents the abrasive action, yet retains the soft rubber cushion, finishing and polishing in one operation.

Brightboy Fine-Tex

Brightboy FINE-TEX

Smoother, finer texture for work on softer metals, producing special finishes and for applications where the coarser wheel might not be suitable.

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Brightboy STANDARD

A favorite for burring, finishing and polishing on the widest variety of metals and metal parts.

- ELIMINATES Grind-to-Buff Production Steps
- ASSURES Outstanding Product quality
- FINISHES All Metals

Get—Catalogs and prices from your distributor; production short-cut suggestions from Brightboy service representatives.

BRIGHTBOY
Industrial Division
Weldon Roberts Rubber Co.
Newark 7, N. J.

WELDON ROBERTS

Brightboy

WHEN THE FLAMES DIE DOWN OVER THERE—

what happens over here?

MERITS OF ALLEGHENY METAL

- ★ Great strength, retained at extremes of heat and cold.
- ★ Tough and impact-resistant.
- ★ Favorable strength-weight ratio.
- ★ Highly corrosion-resistant.
- ★ Inherent, lasting beauty.
- ★ Easy to form and weld.

ON one thing we're all agreed—the lights of industry in this country must die down as little and as briefly as possible, in the turn-back to peace. Getting tools and dies ready—knowing how you'll start, what products you'll make, what materials you'll need—those are patriotic as well as economic necessities *now*, without taking away at all from the first importance of the war.

In working your problems of redesign and new design, when you come to the matter of materials, that's where we can be of help. Remember that the function of Allegheny Metal, pioneer stainless steel in America, is always to *improve* strength, service life, cleanliness, appearance—whatever means most to you.

Call on us for any assistance you need—either in the use of Allegheny Metal or any of our other special alloy steel families: tool and die, electrical, valve or nitriding steels.

Allegheny Ludlum Steel Corporation
Brackenridge, Pennsylvania

ALLEGHENY METAL
The Time-Tested Stainless Steel

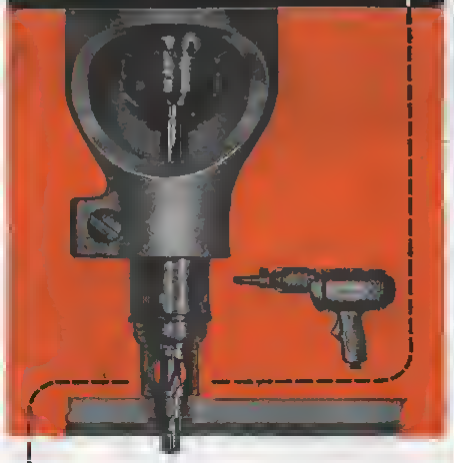
W&D 9495 D

ALSO HANDLED AND STOCKED BY ALL JOSEPH T. RYERSON & SON, INC. WAREHOUSES

SAVE DRILLS AND TEMPLETS

with Zephyr Collapsible

Drill Guides



Perfectly aligned and rigidly mounted, these Drill Guides protect the drill and reduce breakage to a minimum. Takes standard length twist drills thus eliminating cost of special length drills. Reaming of accurately located templet holes is prevented expensive templets are protected . . accurate location of hole being drilled is assured. Standard guide compresses 9/16" with 1" and 1-1/2" optional.

A Tip Style and Size for Every Need

Straight Tips used with straight hole templets.

Cupped Tips for drilling out rivet heads.

Tapered Tips used with tapered hole templets.

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ZEPHYR MANUFACTURING COMPANY

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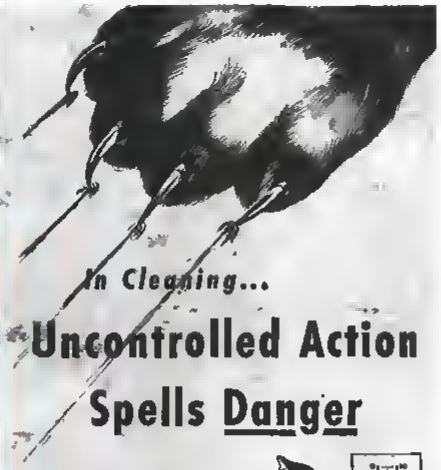
201 Hindry Avenue, Inglewood, California

Dealers located in all principal cities



In Cleaning...

Uncontrolled Action Spells Danger

...pH means control

In chemical cleaning and processing, which is our business, as in everything else where the natural laws of chemistry and physics are involved, action and reaction should be kept under control.

An industrial cleaning compound must have real strength with plenty of reserve power to do a good job consistently, day after day, but added strength is not always the answer to unsatisfactory results. You need the *right kind of strength* held in at the exact degree of cleaning power which is best for the particular job in hand. This calls for an accurate method of control—Kelite pH Control!

By constant adherence to the pH chart, which accurately measures the cleaning power needed for every type of soil removal and shows the exact limits of safety for the surface being cleaned, Kelite has taken the guesswork out of chemical cleaning and processing—provided *the key to maximum efficiency.*

Take a look at that operation you've been worrying about. If you think it might be handled with a little more speed . . . if you think costs may be running higher than necessary . . . if the present method seems rough on the surfaces being cleaned or processed . . . call in your local Kelite Service Engineer. Let him show you how the application of pH Control can assure speed, economy and safety in cleaning.

Wherever there's dirt, grease, grime, scale, corrosion or any undesirable deposit or contamination, Kelite materials with pH Control can solve the cleaning problem.

***KELITE**

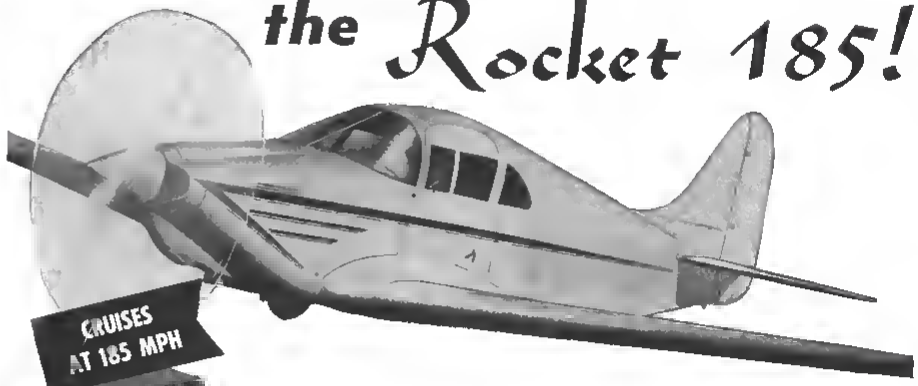
KELITE pH Control

SCIENTIFIC CLEANING THROUGH pH CONTROL

* Kelite * Reg. U. S. Pat. Off. Chart copyrighted 1945 by Kelite Products, Inc. Executive Offices, 3090 East 68th Street, Los Angeles 1. Manufacturing plants in Los Angeles, Dallas, Chicago, and Perth Amboy. Branches in principal cities.

It's in the Air Now . . .

the Rocket 185!



CRUISES AT 185 MPH

LANDS AT 50 MPH

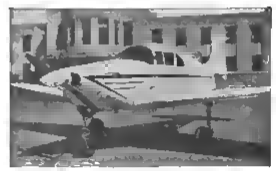
CLIMBS 2000 FT. PER MIN.

OPERATES FOR ½c PER PASSENGER MI.

SAFER, FASTER, EASIER TO FLY . . . MORE COMFORTABLE, MORE ECONOMICAL

From Chicago to New York non-stop in a little over 4 hours — that's the ROCKET 185. Designed to cruise at 185 MPH — the ROCKET climbs 2,000 ft. per minute at sea level and reaches a service ceiling at 24,500 ft. The hydraulically controlled 0° to 60° flaps and the special Johnson wing tip give the ROCKET a landing speed of approximately 50 MPH. 110" tricycle landing gear with large main and nose wheels eliminates ground looping and nosing over. The automatic variable pitch propeller assures correct pitch for highest efficiency under all flight conditions. Three-way trim tabs and wide 3-passenger seat, plus high dynamic stability, make cross-country or routine flying a restful dream in the new ROCKET 185. Standard equipment includes blind flying instruments, engine instruments, 2-way radio, homing loop and navigation lights. Order now from your Rocket dealer for early delivery. Price, fully equipped . . . approximately $5,000.00. Write for free catalog folder for details and specifications.

Beautiful instrument panel contains all instruments, controls, indicating lights, etc., usually found only on airline type planes



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A Rocket franchise may be open in your territory. . . . Write at once for full information.

THE ROCKET AIRCRAFT SALES CO.

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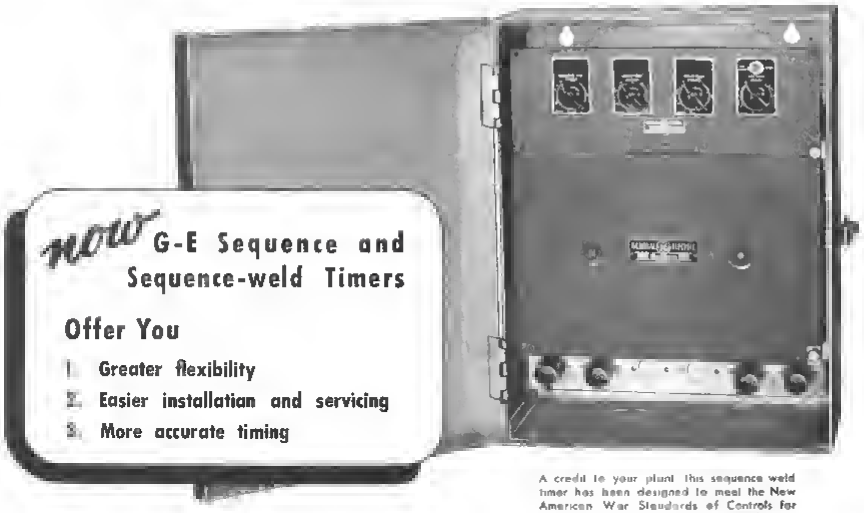
AN IMPROVED LINE OF TIMERS FOR RESISTANCE-WELDING MACHINES



now G-E Sequence and Sequence-weld Timers

Offer You

1. Greater flexibility
2. Easier installation and servicing
3. More accurate timing

A credit to your plant this sequence weld timer has been designed to meet the New American War Standards of Controls for Resistance Welding Machines (C52.4)

IF YOU are using Air-operated welders, you will be interested in this completely redesigned line of sequence and sequence weld timers which provide consistent and automatic timing of the complete welding cycle. It includes controls for all standard combinations in which ignitron contactors or synchronous-precision timers are used

You can change welding sequence easily—Each control is constructed in such a way that the timing control section can be removed in less than a minute—and placed in another machine. This feature is particularly desirable for assembly-line welding because a single spare unit can be used to replace any one of a number of similar timing control sections. And, consequently, servicing will not hold up production.

Also, when production-line requirements change, timing control sections of different types can be interchanged quickly without rewiring.

Because the timing control section can be removed easily (making readily accessible the terminal boards and mounting holes), installation of the complete timer is greatly simplified.

A new and more accurate timing circuit provides consistent welding speed as required for high production welding with short timing intervals, despite nominal variations in line voltage.

Long tube life—The new G-E metal thyratron tube, installed in the timing circuit, will keep this control operating precisely for a long time.

Remote operation—For the convenience of the operator in making adjustments, the timing-control station can be removed easily and mounted on the welding machine or elsewhere.

Built for Your Servicemen

These relesignal controls have many additional features which simplify routine inspection and servicing. Standard industrial-type relays, with which your electrician is familiar and which are easy to service, have been used throughout. Also, by redesigning the wiring system and mounting most of the small resistors and capacitors on a terminal board, servicing has been greatly facilitated.

Need More Information?

Your local G-E office will be glad to tell you more about the jobs that these controls can do—and are doing. Or write directly to us for more information. *General Electric Co., Schenectady 5, N. Y.*

GENERAL ELECTRIC

RESISTANCE-WELDING CONTROL

Buy all the Bonds you can—*and keep all you buy*

EVANS SKY PRODUCTS

can change a plane *quickly* from a cargo-carrier to a passenger carrier or to a combination of both. This plane interior illustrates only one of many ways in which Evans Sky Floors, rod-and-hook tie-downs, rope tie-downs, pulljacks, Sky Chairs and other Sky Products can be used to make a plane a multi-purpose plane

FLEXIBILITY MEANS PROFIT

With Evans Sky Products you can change a plane *quickly*, without structural alteration, from a cargo-carrier to a passenger plane or to a combination of both. That means keeping the plane operating and "in the air" more hours per day. And *that* means greater profits!

The rapid development of Evans Sky Products in the past few years, due to war's demands, forecasts a much wider variety of applications for peacetime Air Transport . . . and promises the air-traveling public and shippers of air-cargo, more flexible, more *useful* flying service.

Evans engineers plan constantly for even greater progress in the flexibility of Sky Products . . . and their services are always available to airline operators and airplane manufacturers. Write for the latest issue of the illustrated, informative publication "Sky Loadown."

Sky Products Division

EVANS PRODUCTS COMPANY

DETROIT 27, MICHIGAN

EVANS DETROIT PLANT FLIES ARMY-NAVY "E" PENNANT

Upper—K-712-DD-8D angle plug valve with flange. *Lower Left*—K-717-CT-4D angle plug valve. *Lower Right*—K-705-CD 1/8D angle plug valve.

THE steadily growing demand for Kohler aircraft valves and fittings is the result of unfailing precision of manufacture and prompt deliveries. You avoid subcontracting delays when you specify Kohler, because complete facilities for forging, machining and anodyzing are all centered in the Kohler plant.

With increased production, various additions have been made to the wide range of Kohler types and sizes. The K-712 DD 8D, shown above, is a new valve in the Kohler line. It is also available in the 12D size. The K-717-CT is now made in two sizes—4D and 8D.

The fact that Kohler valves and fittings live up to the 72-year tradition of Kohler quality is attested by the "approved" rating for quality control which the Army Air Forces have accorded them. They are now used in large volume by the Army and Navy Air Forces and leading aircraft manufacturers the country over. Write today for a free copy of the catalog, *Kohler Aircraft Valves and Fittings*, Kohler Co., Dept. AV-7, Kohler, Wisconsin. Established 1873.

Buy and Keep U. S. War Bonds

KOHLER OF KOHLER

PLUMBING FIXTURES AND FITTINGS • HEATING EQUIPMENT • ELECTRIC PLANTS

NOTE: This New Model Thunderbolt carries 10 — 5" high velocity rockets, 2 — 500 lb. bombs and 8 — 50 caliber machine guns. It has a combat range of over 1000 mi. and a speed exceeding 450 m.p.h.

DEOXIDINE

Prepares these and many other ordnance parts properly for finishing

Proper cleaning and finishing helps insure the effectiveness of rockets and bombs on their crucial mission of death and destruction.

The unusual type of metal required for Rockets presents special difficulties to manufacturers in meeting specifications for cleaning and conditioning. There are types of DEOXIDINE which will enable fabricators to meet these government requirements.

ACP Technicians have assisted many producers of Bombs and Rockets in solving their cleaning and conditioning problems. This experience is available to you in selecting the type of DEOXIDINE and the process best suited to your production requirements.

PEROLINE

Protects metals from rust during fabrication, in storage or transit. PEROLINE is a combination oil and chemical which, when the oil phase is removed (with a vapor degreaser or suitable solvents) leaves the surface properly conditioned for paint or other finish. Peroline is of special interest to subcontractors for protecting parts in transit.

Technical Service Data Sheets on DEOXIDINE sent on request to Department J-7.

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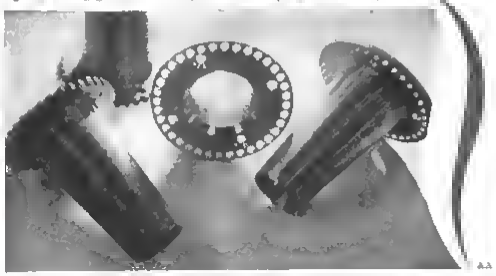
Propeller blade bushings of Ampco Metal—typical of the many Ampco Metal parts which are standard equipment in aircraft propellers, engines, landing gears, wheels, windshield wipers, and various parts.



parts of Ampco Metal contribute to safety and dependability . . .

At critical points—subject to wear, impact, fatigue, or corrosion — parts of Ampco Metal last several times as long as ordinary bronzes. Where performance depends on holding physical characteristics of the metal within narrow limits, Ampco's long established production "know-how" and quality control methods assure you of uniformly satisfactory results. Ampco is completely equipped to fabricate the metal by every commonly-used metalworking process—and to assist you in adapting your design to the most advantageous production procedure. Consult the nearest Ampco field office, or write us regarding your problems.

Ask for technical bulletins.

Specialists in engineering—production—fabricating of copper base alloy parts

AMPCO Metal
The Metal without an Equal

Ampco Metal, Inc.
Dept. A-7
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Ampco Field Offices in Principal Cities

"pilot to navigator" . . .

Callite Silver Contacts' quick response to light contact pressures and their excellent electrical conductivity make them the logical choice of Trav-Ler Karenola Radio & Television Corporation for their interphone communication equipment. In the switch stack (SW-141) are four spring temper phosphor bronze electro-tinned contact levers with pure silver contact points supplied by Callite.

Silver contacts are only one of a wide range of contacts manufactured by Callite in standard and special shapes. If you manufacture an electrical device requiring contacts, Callite engineers offer practical help based on our many years' experience. Let us work with you on product development, the selection of materials and re-designing. Callite Tungsten Corporation, 545 Thirty-ninth St., Union City, N. J. Branch Offices: Chicago, Cleveland.

and Callite silver contacts respond quickly in interphone communication equipment by Trav-Ler Karenola

Switch Stack (SW-141)

Callite CONTACTS

Tungsten, Molybdenum, Silver, Platinum, Palladium and alloys of these metals. Callitex Thermostatic Metals. Send for bulletins.

MAKE YOUR AIRPORT PLANS *EXPANSIBLE*

The maximum in utility and the most modern of design are essential to tomorrow's airports. Especially is this true of the smaller airports if they are to become strong air-links in the air-lane chains.

While wartime demands necessarily limit the manpower available for manufacturing civilian airport equipment, it is advisable that plans be worked out ahead of the postwar rush. While your plans are in the early stages, consult Butler engineers on the design and construction of single and multiple private steel hangars, commercial hangars, service and administration buildings and mobile refueling units. From long experience, they can help you plan an airport that will fulfill early needs economically and one that is readily expansible for future needs.

Address all inquiries to: 7406 East 13th St., Kansas City 3, Mo., or 906 Sixth Ave., S. E., Minneapolis 14, Minn.

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BUTLER MANUFACTURING COMPANY

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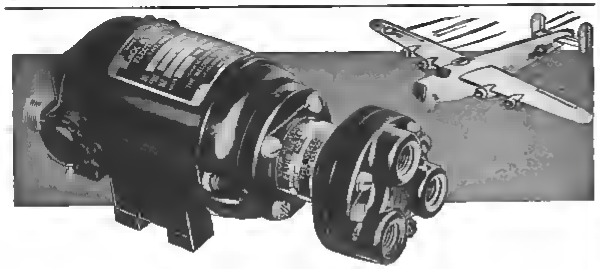
...to build a BOMBER

Airplane structural specifications call for a multitude of pipe and tube bending operations in which Swan Specializes: among them engine ring mounts, landing gear forks, exhaust manifolds, carburetor insert tubes, directional finding loops, oil lines and hydraulic lines. Swan Engineering handles these and other close-tolerance pipe and tube bending jobs on a production basis, meeting rigid delivery dates. Swan's specialized plant facilities and modern streamlined production methods have effected savings in time and money for an impressive list of America's foremost plane manufacturers. Consult a Swan technician on *your* bending requirements! Our engineering department welcomes your special enquiries.

BENDING IS OUR BUSINESS

SWAN ENGINEERING COMPANY, Inc.

744 Frelinghuysen Avenue — Newark 5, N. J.



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Weldon Pumps offer a solution to the problems of simultaneously mixing and accurately metering volumes of two or more liquids or gases.

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3000 WOODHILL ROAD

Approved as "standard equipment" by leading factory engineers and test pilots, Sensenich Propellers may be depended upon for maximum performance. Insist on a Sensenich!

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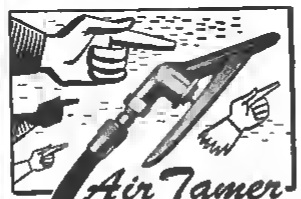
Prompt repair service now available. If your wood propeller — regardless of its make — needs servicing or repairs, send it to Sensenich.

SENSENICH BROTHERS Adjacent to Lancaster Municipal Airport, Lancaster Pa.—West Coast Branch, Glendale, Calif.



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Easy as pointing your finger... *this* blowgun gives the air *where* you want it, *as* you want it. A breeze or a blast! LIGHT and handy but built for tough service. Write C. A. Norgren Co., 220 Santa Fe Dr., Denver 9, Colorado

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the low-cost way to handle aircraft

No matter how large or small the job, how long or short the haul—USAC Trailer Service assures you safe, efficient aircraft hauling — at less cost to you. At the start of each job, trained engineers—expert at transporting aircraft—carefully survey plant or field operations to determine the most efficient handling methods. "Tailored trailers," built and operated exclusively by U. S. Aeroplane Carriers, are constructed for the individual plane or part being shipped. USAC hauling is

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Faster—no needless delays enroute; no platform tie-ups.

More Efficient—trained crews eliminate guesswork and waste motion; loading and unloading simplified.

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Proved in performance for leading manufacturers and military and naval air forces, there are nearly 200 of these dependable units in operation. Let a trained USAC engineer show you how this efficient transportation service can also help solve your aircraft hauling problems. For further information write—

- *SAFELY*
- *QUICKLY*
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PRACTICAL POST-WAR USES

Now aiding war aircraft production by speeding up delivery of sub assemblies to final assembly points, these unique trailers offer you many peacetime possibilities:

MANUFACTURERS
for delivering new planes and parts

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for service and maintenance

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Certified I. C. C. Transportation

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Carry your part of the load

Separate and tie in bundles: 1. Wastebasket scraps. 2. Corrugated boxes, brown paper and bags. 3. Magazines and books. 4. Newspapers.

send every scrap of WASTE PAPER TO WAR

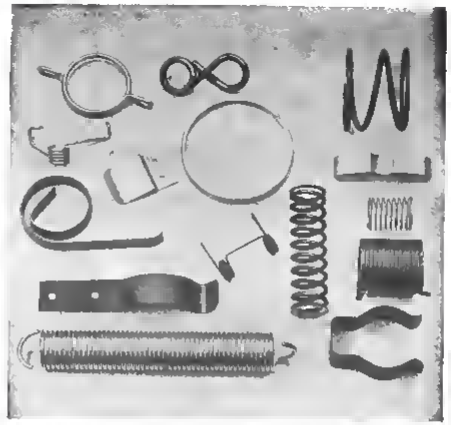
V-E DAY did not ease the waste paper shortage. Paper is *still* urgently required for the millions of tons of supplies being used against Japan as well as for essential home front needs. Double and even triple wrapping is needed to guard against the hazards of the long sea trip and such conditions as jungle dampness, dry rot, and insects.

That's why waste paper is still a No. 1 war material shortage. All old paper not actually useful in your business is needed *now*. Dig out those old files and records!

A good way to get waste paper collected is to *appoint a Salvage Chief* in your office. Let that person take charge of getting all your old paper bundled and turned in. Then . . . if it isn't collected regularly, he should call your local Salvage Committee.

And remember, the only way to help avoid further drastic cuts in civilian paper allotments is for *everyone* to save waste paper.

This advertisement prepared by the War Advertising Council in cooperation with the War Production Board and the Office of War Information. Space contributed to the Waste Paper Program by this publication.



If You Must Be Dead-Sure You Have the Right Spring—See RELIABLE

With the gradual expansion in production of all kinds of mechanical goods, for normal civilian uses, there will arise *new* needs for precision parts. If, in re-designing *your* products, your spring requirements are more exacting than ever before—look to RELIABLE for such service. Springs are an extremely small item of cost—but on their accurate performance may depend the service record of *your* equipment. Therefore the *best* spring is the *only* spring for a quality product. With expert engineering, and with a high degree of precision in manufacture, RELIABLE has met many difficult problems covering an almost endless range of specifications. In every department of spring production, our facilities are exceptional.

Remember, too, that on wire forms and small steel stampings, RELIABLE will give you the kind of *personal* cooperation that saves time, trouble, and costs. Be sure your springs are *Reliable*.

Catalog 44 sent on request.

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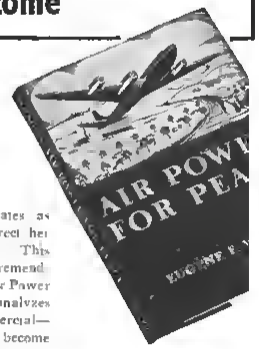
YOU CAN RELY ON Reliable Springs
ROUND AND FLAT WIRE SPRINGS · CLIPS · WIRE FORMS · LIGHT STAMPINGS

The case for Air Power in shaping the world to come



How air might will figure in maintaining peace and in abetting world economic security.

How should the United States as leader in the air today, direct her vast power in peacetime? This book lays before you the tremendous potential influence of Air Power in the world to come, and analyzes how, as a military—commercial—industrial factor it may become the instrument for forging a durable peace.

Just Published!

AIR POWER FOR PEACE

By Eugene E. Wilson

184 pages, 5½ x 8, 6 charts, $2.00

THIS book presents a new view of the use of Air Power as a means of maintaining physical security and achieving economic stability in the peace—through increased international commerce stepped-up aircraft production and technological development and a Security Air Force. Stressing the role of the United States as chief power in the air today, the author traces the development of aircraft production in this country, the rise of air commerce, the integration of Air Force with military and naval strategy, and the role of the air arm in all the major battles of this war.

Here is the full drama of Air Power as a new and revolutionary means of transportation and communication, and the role it is ready to assume as it achieves maturity, in shaping a new "air world."

Here are the aviation problems of the peace, posed against a description of their background, so that the reader may gain a clearer, broader perception of the import and might of Air Power in the world to come.

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Graduate engineer or equivalent, experienced in the design and development of special and experimental machines. Men with creative ability required, experienced in such lines as automatic, semi-automatic, or ordnance equipment.

Must be thoroughly acquainted with modern methods and shop practices and capable of developing new ideas in conjunction with modern mechanical laboratory facilities.

State age, marital status, details of education, experience, draft status, present salary and salary expected. Enclose recent photograph or snapshot.

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NEW ADVERTISEMENTS received by July 19th will appear in the August issue within space limitations

POSITIONS VACANT

WANTED: YOUNG man to develop privately owned commercial airport now in planning stage, successful applicant can grow with field, should know traffic, flying problems and have managerial knack, prefer college graduate and pilot. Write P-924, Aviation, 330 W. 42nd St., New York 18, N. Y.

PRODUCTION ILLUSTRATOR: Capable of drawing free hand perspectives from blue print interpretation of mechanical subjects. Permanent post-war program, long established manufacturer measurement and control equipment. Pittsburgh area. Send complete details—experience, salary requirements, prints of work produced if available. P-928, Aviation, 330 W. 42nd St., New York 18, N. Y.

WENTWORTH INSTITUTE, Boston, Mass. is planning to establish a two-year day course in airplane maintenance engineering for training airplane mechanics and airplane engine mechanics next September. A capable experienced man is needed to take charge of this course of instruction. Applications for this position should be sent to the Principal at 550 Huntington Ave., Boston 15, Mass.

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AVAILABLE — EXECUTIVE — Exceptional knowledge of operation and maintenance of aircraft. Several years Latin American experience. Fluent Spanish. Several years experience Naval Aircraft. Thorough knowledge BuAer procedure. Opportunity desired with operating or manufacturing company to demonstrate diplomacy and ability on difficult job. PW-922, Aviation, 330 W. 42nd St., New York 18, N. Y.

SUPERINTENDENT FOREMAN: Ten years aircraft experience including plant, field and major airline work. University graduate. Civil aeronautics administration's "A" and "E" license. Lately in charge of aircraft maintenance service and flight at the experimental station for army air forces in Europe handling all types of aircraft and their accessories. Will consider domestic or foreign offers. Complete credentials on request. PW-925, Aviation, 330 W. 42nd St., New York 18, N. Y.

ANALYST MAINTENANCE Engineer. Age 37. Exceptional record large scale maintenance and improvement of aircraft availability in military aircraft. Some Latin American experience. Excellent Spanish. Position desired with aggressive airline in need of obtaining more flight hours from available aircraft. PW-921, Aviation, 330 W. 42nd St., New York 18, N. Y.

REPRESENTATIVE AVAILABLE

AN AUSTRALIAN commercial pilot now on duty in America, wishes to contact executives of an American Aviation Company interested in representation in Australia. Squadron Leader S.C. Middlemiss O/C.R.A.A.F. Pacific Ferry Detachment, N.A.S. San Pedro, Calif.

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$50.00 will be allowed for any type of old parachute toward the purchase of a new Irvin or Pioneer Parachute. Canopy must be clean. Age and condition of harness immaterial. Joe Crane & Co., 90 Main Street, Mineola, L. I., N. Y.

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This aircraft is a low-wing monoplane of composite wood, steel and fabric construction and is powered with two Jacobs Model L4MB engines, of 225 horsepower each. These Army models, designated as UC-78 and AT-17 (commercial model T-50), are type-certificated but individual planes must be repaired and modified to meet Civil Aeronautics Administration airworthiness requirements for civilian flight.

Information concerning sales procedure, location of aircraft, and price, may be obtained from your nearest Sales Center.

PRICE DETERMINATION

Prices for these planes have been set to make allowances toward modifications, repairs and overhaul. The $8800 price is for planes equipped with constant speed propellers, and a wing which is eligible for CAA approval to permit a 5400 pound gross weight. Prices are lower for planes equipped with fixed pitch wood propellers and/or a wing designed for a 5100 pound gross weight.

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(Cities listed alphabetically by States)

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Tucson, Arizona	Ryan
Wickenburg, Arizona	Echeverria
Pine Bluff, Arkansas	Grider
West Helena, Arkansas	Thompson-Robbins
Blythe, California	Gary
Concord, California	Sherman
Fresno, California	Chandler Field
Hemet, California	Ryan
Ontario, California	Cal-Aero
Denver, Colorado	Rutledge
Miami, Florida	Chapman
St. Petersburg, Florida	Ludwig-Sky Harbor
Americus, Georgia	Souther
Augusta, Georgia	Bush
Douglas, Georgia	Municipal
Lansing, Illinois	Ford-Lansing
Indianapolis, Indiana	Sky Harbor
Davenport, Iowa	Cram
Wichita, Kansas	Municipal
Baton Rouge, Louisiana	E. Baton Rouge Parish
North Grafton, Massachusetts	North Grafton
Lansing, Michigan	Capitol City
Minneapolis, Minnesota	Victory
Clarksdale, Mississippi	Fletcher
Madison, Mississippi	Augustine
Cape Girardeau, Missouri	Harris
Kansas City, Missouri	Municipal
Robertson, Missouri	Municipal
Sikeston, Missouri	Harvey Park
Helena, Montana	Municipal
Omaha, Nebraska	Municipal
Reno, Nevada	Reno
Readington, New Jersey	Solberg-Hunterton
Albuquerque, New Mexico	Army Air Field
Albany, New York	Albany
Rochester, New York	Municipal
White Plains, New York	Westchester County
Charlotte, North Carolina	Cannon
Akron, Ohio	Municipal
Cincinnati, Ohio	Lunken
Muskogee, Oklahoma	Hat Box
Oklahoma City, Oklahoma	Cimarron
Ponca City, Oklahoma	Municipal
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Pittsburgh, Pennsylvania	Bettis
Bennettsville, South Carolina	Palmer
Camden, South Carolina	Woodward
Sioux Falls, South Dakota	Sioux
Jackson, Tennessee	McKellar
Union City, Tennessee	Embry Riddle
Ballinger, Texas	Bruce
Coleman, Texas	Coleman
Cuero, Texas	Municipal
Fort Stockton, Texas	Gibbs
Fort Worth, Texas	Hicks
Houston, Texas	Municipal
Lamesa, Texas	Lamesa
San Antonio, Texas	Municipal
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Vernon, Texas	Victory
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Alexandria, Virginia	Hybla Valley
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All of the above types formerly were used by the Army and Navy in their respective pilot training programs.

Information on sales procedure, location of available aircraft, and selling prices may be obtained from your nearest Sales Center.

SALES CENTERS

(Cities listed alphabetically by States)

LOCATION	AIRPORT
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Phoenix Arizona	Thunderbird II
Tucson Arizona	Ryan
Wickenburg Arizona	Echeverria
Blytheville Arkansas	Orr
West Memphis Arkansas	Thompson-Robbins
Blythe California	Gary
Concord California	Sherman
Fresno California	Chandler Field
Hemet California	Ryan
Ontario California	Cal-Aero
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Hazlehurst Georgia	Municipal
Lansing Illinois	Ford-Lansing
Indianapolis Indiana	Sky Harbor
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Fort Stockton Texas	Gibbs
Fort Worth Texas	Hicks
Houston Texas	Municipal
Laredo Texas	Laredo
San Antonio Texas	Municipal
Stamford Texas	Arledge
Vernon Texas	Vernon
Salt Lake City Utah	Municipal No 1
Alexandria Virginia	Hybla Valley
Morgantown West Virginia	Municipal

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IT happens to the best of mechanisms, even today. Plans for improvement affect every moving part—but the spring. It may have worked well enough—it still works. Why change it?

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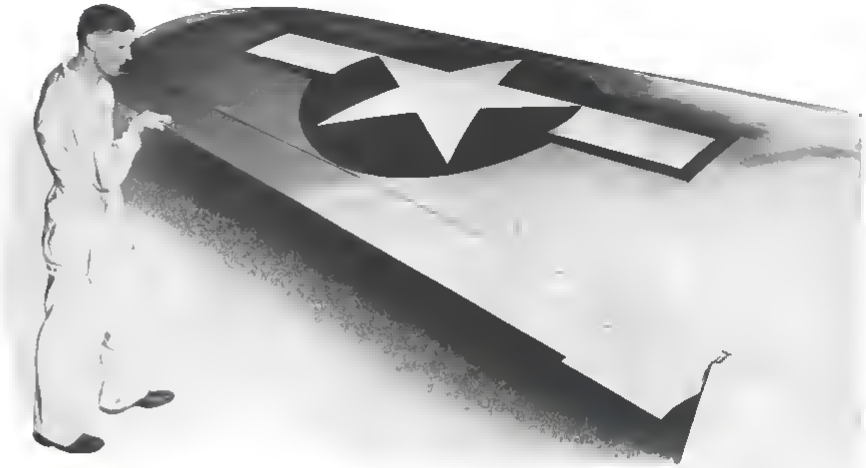

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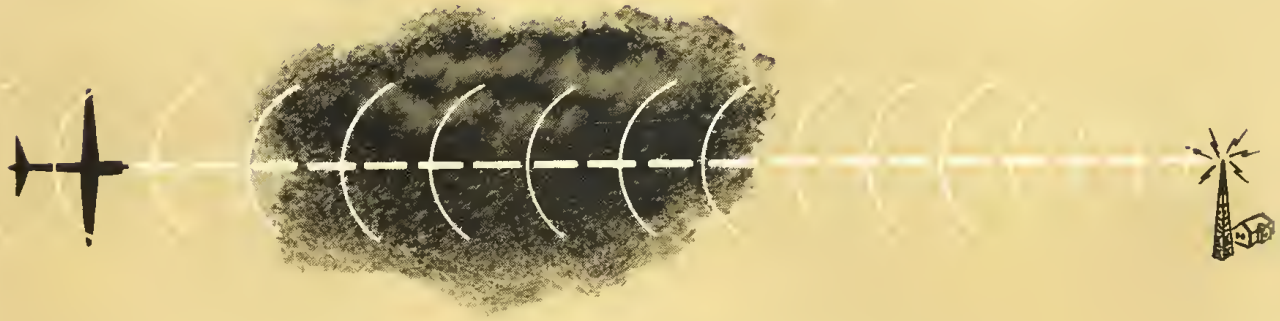

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